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EDITORIAL

Research in Physics is guided by an intense scientific endeavour to extend the existing limits, limits of physical knowledge, limits of experimental uncertainties and limits of known methods. There are physicists who have a passion for precision. Theodor Hansch of Max Planck Institute of Quantum Optics in Garching and Ludwig-Maximillians-Universitat in Munich is a physicist who spent his lifetime to take Physics at the limits with a great passion to improve the precision of frequency and time measurements. Time is one of the fundamental physical parameters that we understand little, but it is a parameter that we can measure most accurately today with unprecedented precision. Much of the credit for this achievement goes to Hansch. In 2003 I delivered a keynote address at a National Symposium at Chandigarh ; it was based mainly on the work of Hansch. At that time I had the apprehension that he would join the list of those most deserving physicists whose work were not recognized by the Nobel Committee. He had co-authored with Arthur Schallow the publication on laser cooling of atomic motion in which light pressure can be used to decelerate an atom. Schallow received Nobel Prize in Physics in 1981 for his large contribution in laser physics. In 2001 a book on the achievements of Hansch was published on the occasion of his sixtieth birthday. It was a dream of many of us, the laser physicists throughout the world that Hansch would get a Nobel prize some day. This dream is realized this year when the Nobel Committee awarded the prize to Hansch along with two other veteran physicists Roy Glauber and John Hall of USA, who made immense contributions in quantum optics and laser spectroscopy.

The recognition of the works by Hansch and Hall is a landmark decision in many ways. It is an inspiration to physicists who are keen to measure physical quantities useful to umpteen significant digits. Many times such work is done for the pleasure of measuring something beyond the existing limits. Physicists have often to ask "simple" questions that a child often asks to know the world that is "new" to him. Such questions and the relevant answers can unfold many of the secrets of Physics. The improved accuracy of measurement of frequency and time finally led to solving many of the intricate problems of theoretical physics and it led as well to the development of precise atomic clocks and global positioning systems. It is significant that basic research supported over a long period of time in Munich and Colorado has finally yielded results of useful applications.

It is well known that hydrogen atom had a central position in the history of twentieth century physics. As the simplest of all atoms hydrogen atom played a key role as a test of fundamental theories and hydrogen spectroscopy is associated with the successive major advances in the development of physics. Over a period of four decades there was a billion-fold increase in resolution of hydrogen spectroscopy. There were two dramatic changes in the relative accuracy of measurements. Hansch was responsible for both. In 1972 his group used laser saturated absorption

spectroscopy as a brilliant method to suppress the first order Doppler effect. Ultraviolet resonance line of hydrogen was measured with unprecedented resolution of one part in 10^{13}. In the decade of ninety Hansch and his collaborators developed frequency comb generators. The discovery was the culmination of a long series of competition for achieving higher accuracy among the researchers at Stanford, Paris, Yale and Munich. The frequency comb device provided millions of closely spaced and stable reference frequencies ranging from radio frequency to the optical region. This device allowed Hansch to count the frequency of a hydrogen transition with an astonishingly high accuracy of one part in 10^{14}. Because of this measurement Rydberg constant is now the best-known fundamental constant in Physics. This device revolutionized not only the field of laser spectroscopy, but also the entire field of metrology.

Measurement of a two-photon transition frequency of hydrogen by Hansch led to the value 2 466 061 413 187 103 Hz with an uncertainty of 46 Hz. Along with the value of another measured transition frequency these results can be used as a test of qantum electrodynamics, that forms the basis of our understanding of bound states of simple atoms like hydrogen. The extraordinary high precision of measurements has stimulated intensive theoretical calculations. Unfortunately, accuracy of theoretical calculations still lags behind the experimental results ; because any theoretical calculation should involve the finite mass and charge of the electron. Both of them are known with less accuracy. Quantum Electrodynamics (QED) has still a long way to go. It is also to be emphasized that the world is not completely described by QED, so physicists are trying to investigate very small effects in atomic scale, coming from weak, strong and gravitational interactions. The laser spectroscopic techniques have been used by the Colorado group to measure parity violating transitions in cesium. This shows that the states of an atom do not have definite parity at this level. High precision and high sensitivity measurements would unfold some of the mysteries of the universe.

Prof. P. N. Ghosh

"Every thought which genius and piety throw into the world alters the world."

– Emerson

PRESIDENTIAL ADDRESS

THE PLACE OF GEOLOGY IN THE LIFE OF A NATION

DR. L. L. FERMOR, O.B.E., D.SC., A.R.S.M., F.G.S., M,INST.M.M., F.A.S.B.

GENERAL

To accept an invitation to preside over the Indian Science Congress is to accept a great honour, and I thank you gratefully, fellow-scientists, for this. But it is also to undertake a great responsibility, not the least portion of which is to deliver a Presidential Address at the commencement of the Session.

Before dealing with the special subject of my address, it seems desirable that I should first notice a few events and matters of interest or importance to scientists in India, including a reference to three of your Past-Presidents.

The first is Dr. Martin O. Forster, your President at the 12th Congress held in Benaras in 1925. He is due to retire shortly from the responsible position of Director of the Indian Institute of Science at Bangalore, a post that he had held for over 10 years. As scientists, we thank him for the fruitful work he has done at Bangalore in supervising and stimulating the development of research ; and as friends we wish him happiness and a further spell of usefulness on his return to England.

Dr. Forster is to be succeeded by Sir C. V. Raman, your Preseident at the 16th Congress held at Madras in 1929. The high quality of Sir Chandrasekhara's work at the Indian Association for the Cultivation of Science in Calcutta and as Palit Professor of Physics at the University of Calcutta, and his inspiring leadership in the development of a school of workers in Physics, is a happy augury to the application at Bangalore of a further stimulus to scientific research at that southern centre. Calcutta's loss will be Bangalore's gain. At present Calcutta may be regarded as the centre of scientific research in India ; but, with the transference to Banglore of one of her leading investigators, she will have to guard her laurels.

The third Past-President I wish to mention is Lt. Col. R. B. Seymour Sewell, who is leaving India in April on leave preparatory to retirement from his post as Director of the Zoological Survey of India. We are not, however, at once to lose his services completely, for he has been appointed to lead the Sir John Murray Oceanographic Expedition to the Arabian Sea. Many of you are familiar with the results of the famous research expedition of H.M.S. Challenger, which, during the years 1873-76, explored the oceans of the world. The results of these researches are embodied in a monumental set of Volumes issued over a period of nearly two decades under the editorship, first of

* General President, Twentieth Indian Science Congress, held during 31st January to 5th February, 1933, Patna.

Sir C. Wyville Thomson and later of Sir John Murray. The survey of the oceans was not, however, complete, the study of the Arabin Sea being omitted. Sir John Murray in his will left a sum of money for this survey, and now that it has been decided by his trustees to complete the task, they may be regarded as very fortunate in having been able to secure the services of Col. Sewell, with his wide experience of oceanographic research obtained as Surgeon-Naturalist to *R.I.M. Investigator*. We wish Col. Sewell every success in this new field of activity.

To one other scientist I must refer, namely Sir Ronald Ross, who died at the age of 75 during the past year. You are all aware of his discovery of the method by which the parasite of malaria enters the human body, and of the enormous development in Tropical Medicine that has followed upon that epoch-making discovery. Ross' work was done in India and it has led to untold benefits to millions of inhabitants both of India and of other tropical countries. Sir Ronald left India before the foundation of our Congress, so that we shall honour ourselves by recording our great loss in the death of one of the most distinguished scientists who has ever worked in India.

An event of major importance to the development of Science in India during the past year was the decision made by a group of scientists during the last session of the Indian Science Congress at Bangalore to publish a scientific journal on the lines of the well-known English weekly journal, *Nature.* A committee was appointed and eventually the publication has been commenced of a monthly journal entitled *Current Science ;* the first issue appeared in July, 1932. You will all agree that the journal is a sucess, for there has been no lack of material suitable for publication and the journal is pleasantly printed on good paper. On one point, however, the Board of Editors had cause for anxiety. The University of Madras and the Indian Institute of Science have made grants towards the maintenance of this journal, and, in addition, there are receipts from the sale of the journal and from advertisements. The total receipt from these sources is not, however, suffcient to meet the total expenditure, and for its continuance the journal will require either additional grants from other bodies, or an increased number of subscribers. These are hard times and it is going to be diffcult to secure donations from university bodies. But when I mention that the present year's budget of the journal has been framed on the basis of only 300 subscribers, which is less than one per million inhabitants of the country, and that 200 additional subscribers would square the budget, it will be seen that if Indian Science deserves that diginty of supporting an All-India journal in Science, it can easily secure this dignity by what is really a trivial increase in the number of subscribers ; for what are 500 subscribers amongst over 300 million people. No doubt, many of you have been waiting to see what the journal was like before subscribing. Now that you see result, I hope that as many as possible will send in their subscriptions.

It has been suggested that as Indian Science Congress may be regarded as the parent of this journal, the Congress should make a substantial annual grant to current Science. This suggestion will no doubt be considered fully by the council of the Congress, but we must remember that our

Congress is not financially a profitable organisation, and is itself dependent at each session upon generous donations from universities and other bodies and from the Local Government concerned, in augmentation of the subscriptions of the members of the Congress.

As this is the 20th Session of our Congress, introducing the 20th year of our existence, a few remarks on our progress may be appropriate. The history of the foundation and growth of the Indian Science Congress was given by Dr. J. L. Simonsen in his Presidential Address to the 15th Congress. This history can be accepted as authoritative, as Dr. Simonsen was as you know, one of the Joint Founders of the Congress. From his address you will discover that the initital meeting that led to our formation was held in 1912 in the rooms of the Asiatic Society of Bengal, and that it was resolved that the Asiatic Society of Bengal be asked to undertake the management of a Science Congress to be held annually. The first Congress was held in Calcutta in 1914 under the aegis of the Asiatic Society of Bengal, and we have since been indebted annually to this Society for our resuscitation at each meeting. We have our own two General Secretaries upon whom much work falls, but two of the officials of the Asiatic Society of Bengal, namely the General Secretary and the Treasurer, have all the time done very heavy work for the Congress, particularly in the publication of reports of our meetings and in keeping our accounts.

I use the word 'resuscitation' because until 1931 our Congress had no permanent organisation. In 1913, however, a constitution was adopted whereby we became a continuous organisation under the title of the 'Indian Science Congress Association' with a roll of permanent members, of whom at present we have about 225. In addition we recruit annually Sessional Members, and Student Members. The administrative work of the Indian Science Congress Association is conducted by an Executive Committee of 11 members, including the President, the retiring President, and two General Secretaries, the Treasurer (who is the Treasurer of the Asiatic Society of Bengal for the time being), and the General Secretary of the Asiatic Society of Bengal, who is really the Manager of the Congress and Editor of our Proceedings. In this way the historical connection between the Indian Science Congress and the Asiatic Society of Bengal has been put upon a permanent footing. This means also that the office of the Congress is in the rooms of the Asiatic Society of Bengal and that we receive the services of the General Secretary and Treasurer of that body free of charge. I have mentioned all this to indicate the extent to which the Indian Science Congress is a dependent body financially, and not yet in a position to provide donations towards laudable scientific enterprises such as *Current Science,* or towards endowing particular researches in the manner undertaken by the British Association for the Advancement of Science in England. *Current Science* will no doubt eventually pay its way ; but we could well do with funds for financing special items of research by private workers. We may hope perhaps that eventually donations for this purpose will be forthcoming from generous donors, who may perhaps remember the Indian Science Congress in their wills.

I have referred above to our *Proceedings.* As you know, the Proceedings of each meeting are now published annually by the Asiatic Society of Bengal as a special volume. This special publication dates, however, only from the 9th meeting, The reports of the first 8 meetings were published as special parts in the *Proceedings of the Asiatic Society of Bengal.* This Society has now very generously undertaken to reprint, at its own expense, the Proceedings of the first 8 meetings in a form homogeneous with the later reports. The Proceedings of the 1st, 2nd, 4th and 5th meetings have been issued and those of the 3rd are in the press. For financial reasons, the Society has found it necessary for the present to postpone the reprinting of the Proceedings of the 6th, 7th and 8th Congresses, but we may expect these eventually. In view of what I have said above it is evident that we have been very much beholden for a long period of years to the generosity and assistance of the Asiatic Society of Bengal, and I wish at this place to mention specially the name of Mr. Johan van Manen, the General Secretary of the Asiatic Society of Bengal, who has, for many years, acted as Editor of our Proceedings as well as helping in many other ways. It is also suitable that I should mention specially Prof. S. P. Agharkar, who has been one of our two General Secretaries since 1924, carrying on his duties in turn with Dr. Simonsen, Dr. Morris, and Dr. Dunniculiff, and now with Mr. West, whom we welcome on the Executive Council of the Congress.

I have mentioned that this is our 20th year of existence. What is the object of our existence ? According to our rules, the object of the Indian Science Congress is the 'Advancement of Science in India by the annual holding of a Congress'. The advancement of Science may be effected in two ways. That which occurs first to our minds is undoubtedly the prosecution of research for the purpose of discovering new facts of Nature and, if possible, of explaining the meaning of these facts. But the advance of Science can also be helped by arousing the interest therein of the general public ; for not only does our work conduce in many cases to the welfare of mankind, but it also requires the support of mankind in the provision of facilities and specially in the provision of finance. For both reason, therefore, our Congress is in its annual activities a peripatetic body, meeting in turn in the principal cities of India so that each may become aware of our activities and our needs. This aspect of the scope of our activities may be summarised by the statement that in the first 20 years of our existence, we have met three times each in Calcutta, Madras, and Bangalore, twice each in Lucknow, Lahore, Bombay and Nagpur and once each in Benares and Allahabad, whilst we are now meeting for the first time in Patna. It is desirable also that we should cater for as many branches of Science as possible, not only by the creation of separate sections, of which we now have 9, which collect each the devotees of their own Science, but also in the Congress as a whole as represented by the President and his Presidential Address. It may interest you, therefore, to know that the first 20 Presidents have been distributed as follows—Medicine, Geology, and Chemistry, three each ; Botany and Zoology, two each ; and Geography, Meterology, Agriculture, Physics, Mathematics, Business, and Engineering,

one each. For the next—the 21st Congress—a Physicist has been selected.

The catholicity of our activities both in place of meeting and choice of President, is illustrated by the foregoing figures. The extent to which this catholic behaviour and outlook had been successful is perhaps well-illustrated by the astounding growth in the activities of our Congress. At the first meeting the number of members was 79, one Presidential Address was given, 35 papers were read, and the published Proceedings occupied 8 pages of print. Ten years later, at the 11th meeting, the number of Full and Associate Members was 403, with 290 Student Members. One general Presidential Address and 8 Sectional Presidential Addresses were given, 264 papers were prsented, and the published Proceedings occupied 264 pages of print. At the 19th meeting, the number of Full and Associate Member was 690 and of Student Members 183. There were 10 Presidential Addresses, general and sectional, and 693 papers occupying 467 pages of Proceedings. This growth in the attendance at our meetings shows increasing interest ; but it is a question whether this vast increase in the number of papers presented can be desirable, for in the time available it is impossible to read more than a fraction of the papers offered. Thus at the 19th Congress 221 papers were presented to the Chemcial Section ; it seems unlikely that even a quarter of these can have been profitably read and discussed. Of course, this flood of papers reflects to some extent the activity of research in India in the branches of Science concerned, but one wonders if there is not some room for selection by the Sectional Committees of those papers that are most suitable for presentation at the Sectional meetings, taking into account the general interest and importance of each paper.

This growth in the activities of our Congress has been accompanied not only by a growth in volume but also in the number of recognised sections. The original 6 sections were Chemistry, Physics, Geology, Zoology, Botany, and Ethnography. Agriculture was added at the 2nd Congress. The Physics section became the section of Physics and Mathematics at the 4th Congress, when Ethnography was also amalgamated with Zoology. At the 6th Congress the sections were increased to 7 by the addition of a section of Medical Research. At the 8th Congress, Ethnography was separted from Zoology again and made into a separate 8th section of Anthropology and Ethnography, to become a section of Anthropology at the 9th Congress. At the 12th Congress a 9th section of Psychology was added and these are our 9 sections now.

During the vast growth in the number of papers read at several of the sections, Geology has remained a small section, and the largest number of papers that has been presented at one meeting is 36. The relatively small number of papers offered in this Science is partly due no doubt to the fact that the meetings are held at a time when the officers of the Geological Survey of India are absent on field duties, and to geologists as a whole not caring to offer papers if they cannot be present to read them. Some other sections, e.g. Anthropology and Psychology, also are happy in that a manageable number of papers are presented, and I commend the example of these smaller sections to the notice of some of their bigger brethren.

THE PLACE OF GEOLOGY IN THE LIFE OF A NATION

This brings us to the end of my remarks upon matters connected with the progress and welfare of our Congress. I now propose to discuss, in as general a manner as possible, a subject of more specialised interest, namely the Place of Geology in the Life of a Nation.

Those of you who have pondered upon the relationship between cause and effect must realise that anything that happens now to any person or thing may be regarded as the latest unit in a continuous chain of cause and effect. And you will probably permit me to summarise epigrammatically the results of your thoughts by likening life to an algebraical equation.

As you know, an important feature of such an equation is that the sum of the items on the right side must equal the sum of the items on the left side. Life is rather like this. A present happening may be regarded as the right side of an algebraical equation, and all the events that have led up to this happening may be regarded as constituting the left side of the equation.

To take an example, the fact that I am addressing you this evening, here, depends upon the facts, among many others, that I was born on a certain date, that I took up the study of Science, that I was diverted to Geology from Metallurgy, the profession I originally selected, that I secured an appointment in India, that I have remained in service until this date, that your Council chose this place and date for our meeting and selected me to preside, and that I have succeeded in reaching this room without being involved in any accident. If any one of the facts mentioned had been different, I should probably not be here this enening.

An equation of this type, that is to say one involving cause and effect, differs in one essential particular from the algebraical equations of our class rooms. The equations of our school Algebra are static equations, whereas those of the type we are now discussing are kinetic ones. For one each side of the equations of life there is an energy factor implying movement in the past and the possibility of movement in the future.

It is the energy factor that conditions Evolution, which using our simile, may be described as the grand and impressive kinetic algebraical equation of the universe, on the left side of which is included not only the mangnificent succession of events constituting the evolution of the stellar universe, but also the section of these events that has led to the evolution of the solar system and the birth of our planet ; in addition it includes the much smaller, though to us vitally important, series of events that has led to the evolution of life upon our planet including the evolution of Man, followed by the still smaller series of events that constitutes the progress of human history down to its present point. The major portion of this grand series of events is the field of study of the astronomer. With the formation of the earth, the field of study of the geologist was provided. The evolution of life falls also within the realm of the geologist ; but the latest section of this series of events, affecting human beings, falls within the sphere of studies of the historian. The study of the present results of this evolutionary series of changes falls within the realms of

Geography, Meteorology, Botany, Zoology, and Anthropology to mention Sciences that in their historical or fossil aspect are comprised under Geology.

You will now ask Then what is geology and the true field of study of the geologist ? I cannot do better than quote the two opening paragraphs of Sir Archibald Geikie's *'Textbook of Geology'.*

'Geology is the science which investigates the history of the Earth. Its object is to trace the progress of our planet from the earliest beginnings of its separate existence, through its various stages of growth, down to the present condition of things. Unravelling the complicated processes by which each continent and country has been build up, it traces out the origin of their materials and the successive stages by which these materials have been brought into their present form and position. It thus unfolds a vast series of geographical revolutions that have affected both land and sea all over the face of the globe.

Nor does this Science confine itself merely to changes in inorganic world. Geology shows that the present races of plants and animals are the descendants of other and very different races that once peopled the earth. It teaches that there has been a progress of the inhabitants, as well as one of the globe on which they have dwelt; that each successive period in the earth's history, since the introduction of living things, has been marked by characteristic types of the animal and vegetable kingdoms ; and that, how imperfectly soever they may have been preserved or may be deciphered, materials exist for a history of life upon the planet. The geographical distribution of existing faunas and floras is often made clear and intelligible by geological evidence ; and in a similar way, light is thrown upon some of the remoter phases in the history of man himself.'

From this you will gather that Geography is the branch of Geology that describes the particular shape and form of the earth's surface at the moment. With the continuance of the operation of geological processes, geography changes slowly through the ages, and looking backwards and making use of geological observations, we find that at previous periods in the earth's history the distribution of land and water, of mountain and valley, has often been vastly different from the present.

The geography of the earth at any moment, including its climate, flora and fauna, and the inherent possibilities of further change, is, in fact, the right side of that kinetic algebraical equation, of which the left side is the geological history of the earth down to that moment. In fact, in mathematical parlance, the geography of the earth is a function of its geological history.

Those of you who have studied History, by which I now refer to human history, must have noticed the extent to which this History is related to Geography : how coasts, seas, rivers, mountains, and climates, have exercised an important influence over the migration of races, and their struggles–one race with another, and upon the distribution of tribal and national boundaries. It is probable, nevertheless, that the majority of you have not realised that the guiding factors underlying geography were geological ones, and that, in fact, the events that constitute geological history have exerted a profound and far-reaching influence upon the history of mankind, both in general and in detail.

On the wall here is a geolgical map of the the world.[1] The colours indicate the distribution of geological formations of different ages and origin. As you know, the land of the world occupies about a quarter of the surface, the oceans occupying the remaining three-quarters. According to some geologists, the land area was once vastly greater, and according to most, the proportion of land and sea has varied greatly throughout the ages. One major deduction based on widespread geological evidence is that South America, South Africa, Australia, India, and Antarctica, were once all part of a continuous continent known as Gondwanaland. Views differ as to the method by which this continent was dismemberd. According to one hypothesis, known as the hypothesis of continental drift,[2] the existing continents were grouped in Carboniferous times as on continuous land-mass, with all the existing parts of Gondwanaland in apposition to southern Africa. Subsequently, on this view, the continuous land-mass was fractured, with drifting apart of the fragments to form the present continents. On this view, the continents attached to Africa near Madagascar, and gradually floated or drifted north-eastwards.

The second and older hypothesis, whilst accepting the fact of Gondwanaland, supposes that it was formerly a much larger continent than can be deduced by simply fitting the existing fragments together, that Africa and India were then at approximately their present distance apart, and that the separation of those two countries was effected by the foundering or sinking of the intervening portions of the continent. Some geologists find it difficult to visualise the machinery of foundering, and consequently support in toto the hpothesis of continental drift. Foundering can be explained, however, either by the compression of rocks underlying the sunken parts of the continent into a denser phase, e.g. gabbro into eclogite,[3] or by the lateral underground squeezing of magma from below the foundering portions. Whichever of these hypotheses relating to the break up of Gondwanaland be true, the cause has to be found. I do not propose to discuss this here, but only to point to the fact that the existing fragments of Gondwanaland are now separate, and that India has sea-coasts that she would not have had but for this disruption. Mr. West proposes to discuss the hypothesis of continental drift in one of our evening lectures, so that I need not refer further to this question. As a side-issue I may mention, however, that the expedition that Col. Sewell is to lead to the Arabian Sea may obtain, if rock specimens in any quantity can be secured from the bottom of the ocean, evidence helpful to the determination of whether India has been separated from Africa by the foundering of the inervening land, or by drifting apart.

I will now invite your attention to these two maps of India, one geological and the other orographical. India is a large country, whilst the number of geologists who have been at work therein is small ; in consequence, there are still great gaps in our knowlege, and our geological map is a very imperfect production. Sufficient, however, has been ascertained to reveal the general outline of the geology of India and to render possible a comparison between the geology and the orographical features as

represented in these two maps. From this comparison you see at once that there must be some close relationship between the geology of India that is to say its geological history, and the present topographical features. From these maps you will see also that the Indian Empire, as at present constituted, is one of the most natural geological and physical units on the surface of the earth

Geologically speaking, the Indian Empire may be regarded as consisting of three parts. There is first the Peninsula stretching southwards to Cape Comorin from its apex at Delhi ; it is a remnant of the old Gondwana continent. To the north of this is the second unit, the Indo-Gangetic alluvium, composed of sands and clays, laid down, in geologically recent times, upon what is really a bent-down portion of Gondwanaland. To the north of this alluvium is the third unit composed of three mountain festoons with their convexities directed towards the Peninsula. On the north-west is the first festoon composed of the arcs of Baluchistan and the North-West Frontier Province ; on the north is the second festoon, the magnificent arc of the Himalaya ; and on the north-east, is the third festoon, composed of the mountain ranges of Assam and Arakan and the Andaman and Nicobar Islands.

The northern edge of Gondwanaland is actually on the north side of the Indo-Gangetic alluvium, and lies in the outer ranges of the Himalaya ; the Assam plateau may also be regarded as a fragment of this old continent ; and as the Indo-Gangetic alluvium rests upon what must be regarded as a downwarped portion of Gondwanaland, we can in fact reduce our elements to two, of which one is a fragment of Gondwanaland represented by the Peninsula of India, the Indo-Gangetic alluvium, the outer ranges of the Himalaya, and the Assam plateau. The other element is represented by the three mountain festoons of the north-west, the north and the east, which appear to result from the overthrusting of Asia on to this fragment of Gondwanaland.

There is a difference of opinion whether this relationship has been produced by the underthrusting of the Peninsula of India against the mountain lands of Asia, or by the overthrusting of the highlands of Asia on the Gondwanaland. The resulting Indian Empire, however, is an approximate geological whole with a crude bilateral symmetry about a N.N.E-S.S.W. line that is reflected in the Geography and Orography of the Indian Empire. The exact outer limits of this Empire are, nevertheless, difficult to select on geological and, therefore, geographical grounds, and are dependent upon the details of history ; but there can be no boubt that, looked at from a broad point of view, Burma, or at least the western protion thereof, must be regarded as an integral portion of the Indian geological and geographical unit.

General geological factors have thus given rise to a natural unit comprised of a hilly and wooded Peninsula bounded on the west, south and east by seas and on the north by fertile plains, which are themselves limited by bordering mountain ranges to the north-west, north and east. The protective action of these bordering ranges would have been complete were it not for the operation of more local causes, such as faulting and river erosion in producing the gaps

known as passes. The existence of these passes has had a profoundly important influence upon the human history of India.

Students of this history are aware that through the ages there has been a succession of waves of invading races that have taken advantage of the passes in the high mountain walls, specially on the north-west, but to a small extent on the northeast ; and they are aware how each successive wave of human invasion has pushed the remnants of the previous invasions further south into the Peninsula.

The fact that the Peninsula of India is bounded to the southward by seas was until a relatively late date in the history of India a limiting factor to changes in that history by providing a boundary beyond which the inhabitants could not be dirven by further invasions from the north, and also by acting as an obstacle to the arrival of any disturbing invasions from the south. Later, however, this very factor of the existence of sea coasts, once the Cape of Good Hope had been rounded by the Portuguese investigator Vasco da Gama, provided a means by which invaders from a far-distant part of the world, Europe, were able to reach India. Had, however, the disruption of Gondwanaland never occurred, the Peninsula of India would have remained embedded in a continent and would, consequently, have had no coasts ; there would have been no European invasions by sea and the whole history of the country for the last few centuries would have been profoundly different.

As another instance of the manner in which the existence of the sea has reacted upon the history of India, attention may be drawn to the eastern festoon constituted by the Tertiary mountain ranges of Assam and Arakan. Had their continuation through the Andaman and Nicobar Islands to Sumatra and Java not been breached, these ranges would have acted as barrier between India and Burma almost as effective as that between Tibet and India provided by the Himalayan ranges. The mere fact that events of geological history have caused this range to be discontinuous with the isolation of the Andaman and Nicobar Islands and the provision of the sea passage from India to what is now Rangoon, led in an inevitable manner to the addition of Burma to the India Empire.

To illustrate still further the effect that Geology may have upon the distribution of national boundaries, I invite your attention now to the geological map of Europe, though I regret that I have not been able to provide one on a larger scale. A comparison of this map, or of the corresponding orographical map dependent upon it ; with the political map of Europe will reveal the extent to which national boundaries in Europe are based upon natural factors. You will observe, for example, how the approximate position of the frontier between Spain and France is determined by the existence of the Pyrenees, which with the seas isolate Spain and Portugal as one natural unit. You will see how Italy may be regarded as another natural unit bounded by the Alps on the north and otherwise by the sea. Similarly the Scandinavian Peninsula, composed of Norway and Sweden, is a natural unit ; you will notice also that Finnald is geologically allied to Sweden and not to Russia, so that it is not strange that Finland has succeeded in eventually obtaining her independence from

Russia, although the national boundary between Finland and Russia is not in agreement with the geological boundary.

It will be noticed on the other hand that it is difficult to select on natural grounds a precise position for a frontier between France and Germany, as also for the frontiers of many of the countries of Central Europe. This lack of correlation betwen natural and national boundaries in Cenral Europe may, in fact, be regarded as the ultimate cause of the Great War, a more proximate cause being the ownership of the coal-fields and iron-ores of the Franco-German frontier lands. The broad truth is that in many parts of Europe nationality is on a smaller scale than Geology and is consequently upon a precarious basis : from which it appears, if we may rely upon Geology, that national stability will not be attained in Europe until the countries have in many cases been grouped into much larger units. The results of the partition of the Austro-Hungarian Empire as a result of the Great War provide an example of a particularly flagrant violation of nature ; and economic grounds alone, it may be predicted, will eventually cause racial considerations to be subordinated to common economic interests resulting from physical factors.

Directing our attention once again to India we find we have here a country of the size of Europe without Russia, containing at least as many different races with at least as great a diversity as in Europe. India is fortunate, however, in that the general geological conditions have caused the inhabitants, in spite of their diversity of race, religion and language, to be welded, after struggles through the ages, into one political unit. As with national boundaries in Central Europe the boundaries between the provinces in India pay little attention in many cases to geological considerations. The province of Bihar and Orissa, for instance, in which we are now meeting, is an excellent example of the violation of natural principles by provincial boundaries. But as long as a central political control remains, it does not matter seriously that the boundaries between our provinces take such little account of natural factors. Were the central control, however, removed and all political relationship to one general suzerain power severed, then the future history of India would again become as confused as it was in the past and as confused as that of Central Europe has been throughout the ages and promises to become again in the future.

I have suggested in the short time at my disposal the profound influence upon the history of a nation and upon the determination of its boundaries that may be exerted by geological factors, how relative national stability appears to be attained in cases where natural boundaries are based on physical features, and how the history of a country in respect of its extent and government appears to become confused and doubtful in cases where national boundaries have been laid down in defiance of physical considerations.

Leaving the general for the particular, I propose now to point to a few precise events and sets of conditions in India that can be ascribed to particular events in the geological history of the country.

In the first place we may refer to the position of the capital. There is no boubt that the defence

of any country is one of prime importance, and that, therefore, the position of greatest internal strategic importance may have claims for selection as the capital of the country. A glance at this map will show you that Delhi, by virtue of its position at the apex of the Peninsula, occupies the most strategic point in India, with reference to the internal peace of the country. For Delhi is at the point where the plains of the Indo-Gangetic alluvium that separate the Peninsula from the Himalaya become most constricted, the point consequently at which it is easiest to defend the fertile plains of the Jumna and the Ganges to the east against invasion from the west, the direction from which most of the major external invasions of the past have come. It is not surprising, therefore, that in the past history of India there have been three decisive battles at Panipat[4] in the plains north of Delhi. It is this position at the apex of the Peninsula that caused Delhi to be the capital home of the Moghal Emperors and their predecessors, and which really caused the removal of the capital of India in recent times from Calcutta to Delhi.

But the welfare of a country does not depend only upon defence and politics. Commerce and industry are also of vital importance and, in so far as they are the true source of wealth to a country, their importance may transcend military and political factors. It will be seen that a point somewhere in the delta of Bengal, by its connection with the Hinterland of the Gangetic valley and the highlands of Assam, its sea connection of Burma and Southern India, and its proximity to the coal-fields of Bengal, Bihar and Orissa, seems to be a natural site for a commercial and industrial captial ; it is because of the existence of these underlying natural factors that Calcutta continues to be the commercial capital of India, in spite of the removal of the political capital to Delhi.

The ultimate factors that have caused the selection of Delhi as the political capital of the Indian Empire with the *de facto* retention of Calcutta as the commercial capital date back to the series of events that caused the break up of Gondwanaland, followed by the elevation of the Himalayas and the deposition of the alluvium of the Indus, the Ganges, and the Brahmaputra.

Another important item in the sequence of events following the break up of Gondwanaland was the eruption of the Deccan Traps that cover some 2,00,000 sq. miles of Western India. For it is the eruption of these lava flows that is real cause of the greatness of Bombay. Bombay depends mainly upon the cotton industry, and the latter is dependent upon the fertility of the black cotton soil derived mainly from these lavas. The foundations of Bombay were, in fact laid, when the Deccan traps were poured forth, let us say 75 million years ago.

Other events in the modern history of India can, however, be attributed to dates much more ancient than this ; for example, the institution of the iron and steel industry at Jamshedpur in this province. This industry is dependent for its supplies of iron ore and limestone upon deposits that were laid down in Archean times and upon deposits of coal laid down in early Gondwana times. We may ascribe an antiquity to these deposits of iron ore and limestone of something betwen 600 million and a thousand million years, and to the coal an antiquity of some 200

million years. The foundations of the iron and steel industry at Jamshedpur were thus laid down at periods rangind from, say, 750 to 200 million years ago.

Numerous other examples could be cited of the dependence of particular events or industries upon past events in the geological history of India ; but time does not permit.

The examples given all illustrate the manner in which Geology has affected man, without his being conscious thereof ; they illustrate the action of cause and effect in which mankind appears as the helpless child of Geology.

There is, however another aspect of our subject in which man derives conscious benefit from his geological heritage by utilising the rocks, minerals and structures now lying at or near the surface of the globe. This may be described as the utilitarian side of Geology, and this I have already discussed at some length in my Presidential Address to the Mining and Geological Institute of India in 1922 under the title of the Utility of Geology to Man.[5]

It is unnecessary to enlarge upon this branch of our subject here, except, for the sake of completeness, to mention that on the utilitarian side Geology helps not only in the development of mining and metallurgical industries, but also in many branches of Engineering, both in the provision of materials and in structural problems dependent upon the strength and disposition of rocks such as those connected with foundations, with the study of landslips and earthquakes, and with the alignment of railways. Further, as a result of the development of mineral and metallurgical industries, Geology becomes the cause not only of revenue to Government in the shape of imcome-tax and royalties, but also of the creation of a widening circle of employment, starting from employment to miners and smelters and spreading out to employment for the great transporting agencies, the railways and shipping companies, to mention only a few of the interests that benefit.

But should the conscious use of Geology by man be confined to these directly utilitarian but relatively minor purposes ? Should man not, as a result of his studies of the trend and influence of geological factors on a large scale, attempt so to adjust national and international life to these factors as to help the growth of national welfare and international peace ; instead of, as so often happens, pursuing, in indifference to these natural factors, courses of action that tend to increase national or international disequilibrium ?

It is mainly for utilitarian reasons, however, and partly, perhaps, because in addition it is realised that a country should know herself, that every civilised country maintains a Geological Survey Department for the purpose of ascertaining the factors upon which so much appears to depend.

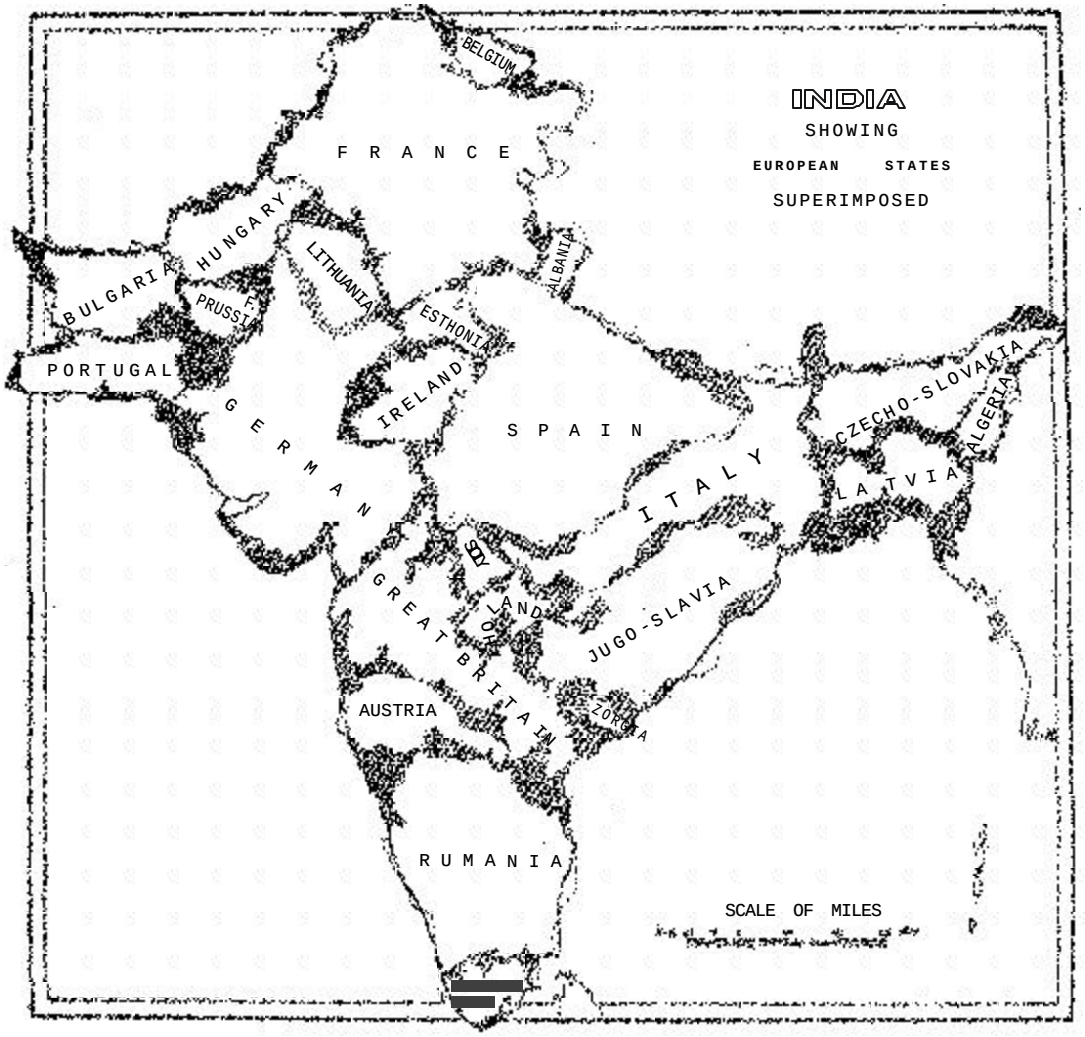
I have already mentioned the approximation between the size of India and the continent of Europe without Russia. This was brought out forcibly in a map published recently by the *Statesman* (see Plate 1) in which Europe was treated as a jigsaw puzzle, and the countries of Europe, 20 in all excluding Russia, Finland, Scandinavia, Poland, Greece, and Turkey, were fitted into India excluding Burma. I show this map now upon the screen. It is diffcult to secure exact figures of the strengths of the geological

surveys of the countries in question. But they amount to over 250, of which 78 are employed in Germany and 52 in Great Britain, whilst several of the less advanced countries, namely Albania, Bulgaria, Esthonia, Latvia, and Lithunia, appear to have no geological survey department. In India we have a staff of 24 for the study of the Geology of the whole Indian Empire including Burma. Of these about 6 are employed in Burma, leaving 18 for the study of an area equal to that for which Europe provides over 250 geologists. Square mile for square mile, India is, of course, much less wealthy than Europe, but from the figures given above it is seen that if India is properly to know herself, she must contemplate in the future—it may be near or it may be distant—the employment of a much larger number of geologists than at present or than were employed before the recent drastic reduction in the strength of the Geological Survey of India effected as a measure of retrenchment. My faith in the value to a country of the work of geologists, coupled with the fact that in India in particular the accrued yearly direct and indirect financial benefits to Governments–Central and Provincial—is several times the annual cost of the Geological Survey Department, leads me to believe that re-expansion, followed by further growth, will eventually and inevitably be regarded as a vital financial necessity, apart even from the influence of general and cultural reasons the importance of which will be increasingly realised.

I have alluded just now to the cultural aspects of Geology. It will be readily apprehended that the study of a subject related so fundamentally to life is admirably suited for inclusion in university curricula. At present the scope for new employment for geologists in India has fallen almost to zero ; but this does not mean that geological classes in university institutions should be closed. For young men should be encouraged to study Geology not for the purpose necessarily of earning their living thereby, but as a branch of general culture, some knowledge of which is desirable to a man in whatever profession or walk of life he elects to earn his living. It is, in fact, not an exaggeration to say that no university that does not provide instruction in Geology can truly and strictly be regarded as a university in the true sense of the world.

I have now reached the end of my address. In attempting to show the importance of Geology in the life of a nation, it has not been my intention to magnify this Science at the expense of others. All the Sciences are inter-related, and Geology in particular makes contact with many others, but specially with Astronomy, Meteorology, Botany, Zoology and Anthropology and also with the two Sciences that deal with matter in its atomic and molecular aspects, namely Physics and Chemisty. Moreover, we live in the present ; the study of the present aspects of nature in her historical aspects, with which Geology is so greatly concerned. The importance of the study of the historical side of nature is, therefore, of as great importance to us as the study of nature lies in the fact that such study helps us to understand how that facts of the present have arisen ; and, because life is a kinetic affair, this historical study helps us to obtain sometimes a glimmering of the future,

and even to suggest, however diffidently, the extent to which a measure of control of the future may lie within the grasp of mankind if we will but have the foresight and the courage.



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TECHNOLOGY TRANSITION : A STRUCTURED APPROACH

Basu D. Sarkar*

Most benefits, which could be obtained through use of a technology that has been developed and successfully used elsewhere, are through transition of that technology, and not by just transferring it. Technology transition is a set of processes and mechanisms that causes the technology to become sucessfully matured and used routinely in a particular environment. It must include not only an analysis of the user needs, but many other related activities such as, enducation, training, experiments, policy changes, standards, reviews, collaboration, meetings, publications, licensing, and a host of others. As such, technology transition is a phased activity to adopt a technology from a producer to the users through a sequency of systematic actvities. It is a painstaking process for the users and the producers. However, once perfected it can be used for most technologies and at a significant reduction in cost and schedule with a high degree of probability of success.

INTRODUCTION

These days the world is permeated with technology. The benefits of utilizing an already tried and tested technology to improve one's ability to modify the environment in order to meet our needs and wants are too many. Most people, however, think of technology in terms of its artifacts : computers and software, aircraft, pesticides, water-treatment plants, birth-control pills, and microwave ovens, to name a few. But technology is more than these tangible products. It includes the infrastructure needed for the design, manufacture, and operation of the technological artifacts. Therefore, the process of utilizing a technology successfully depends on many factors : from appropriateness of the technology to the user's ability to use it.

Unfortunately, the more the glamour, the more attracted we are to the technology. We often ignore whether the technology we want to use has any relevance to our needs at all, or whether the technology may be overkill for solving the problem where it is used. Adoption of a technology, no matter how simple it may be, requires careful planning as well as proper nurturing. The entire process, from the conception of a new idea, through technology development to its widespread use, is a series of systematic activities. The process may include a group of related activities that employ mechanisms such as education, training, electronic media apprenticeship, experiments, policy changes, standards, review meetings, user groups, case studies, publications, licensing, commercial spin-offs, and host of others, in a systematic way with objective use of useful, practical, and expedited application. Successful

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transition of a technology from the developers to the users takes years. A study commissioned by U.S. Department of Defense (DoD) found that it takes an average of 18 years for a selected set of software engineering technologies, from conception to widespread use.

In this paper, the technology transition process is discussed with an obejctive to highlight the systematic nature of the phased activities that successfully moves the technology from a producer/developer to the users through a sequence of transition stages such that the technology can be successfully and routinely used by the users.

A TECHNOLOGY TRANSITION MODEL

Technology transition includes a process that moves the technology from its different states of maturity : concept paper, prototype, finished system, pass from one set of users or organizations to another in a manner that can be characterized as series of transactions. There are processes associated with each transaction with all characteristics of the associated "stakeholders," the key users in technology transition. These transactions can be planned and implemented repeatedly, and consistently with modifications as appropriate by following a structured process.

Figure 1 shows a technology transition model for planning and processing these transactions from the technology producers to the technology users.

All transactions occur in the context of technology producers, and users with a delivery system between the two. In a capitalistic society, the technology producer is concerned with the developing and selling its product so that costs are recovered and profits are generated. In order to do this, the producer is governed by the marketing and selling view. The Technology advocates are groups who assist in selling and marketing the product : packaging, advertising, etc. These product development and maturation activities often consist of Resarch and Development (R & D) activities, product testing, manufacturing and packaging etc. However, the Users are the ones who apply the technology to satisfy a particular requirement. This push/pull relationship between the technology producer and the user is extremely important for the success of a technology transition.

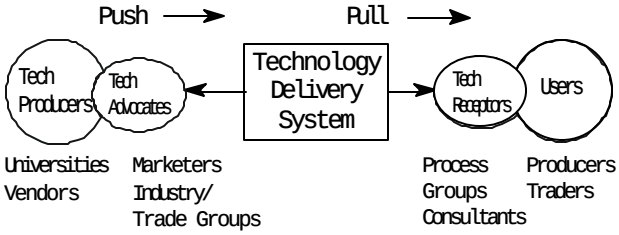

Fig 1. Technology Transition Model incorporates the technology producers and the users.

Figure 1 shows how complicated the communication process can be for technology transition. At least four different groups of special interest groups or organizations can be involved. The efficiency and effectiveness of the transition is determined by how well these groups interact and communicate with each other. There must be specific plans and procedures, a structured process in place in order for the successful transition of the technology. Unfortunately, in today's "need it yesterday" mentality everything is often accomplished in an *ad hoc* manner with no feedabck among the groups. This often causes large communication gaps between the producer of technology and the user, and this often results in an unsuccessful technology transition.

To close the communication gap, available evidence supports the need to address both technological as well as organizational issues. One must understand both the producer and user points of view. To aid in this understanding, maturation and adoption life cycle views are discussed in the following sections.

TECHNOLGOY DEVELOPMENT LIFE CYCLE VIEW

Normally, at the producer end of the cycle, technology is the dominant factor. Very little attention is given to its broad use. Usually, 10% of cost is spent on invention, nearly 90% of cost is spent on development and little is spent on broad dissemination of the product. This itself poses high risks associated with adoption of the technology or its broad use (figure 2).

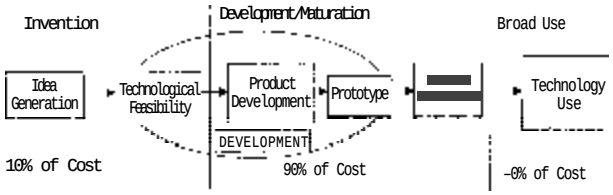

Fig. 2. Technology Transition Life Cycle addresses all phases of technology development : from development to its use

In most technolgy development situations, very little feedback is provided from the user community until the product development is completed. Even if there are plans to involve the users in the development stages, such efforts are often ignored. Also these plans are generally developed with a technological view and executed without explicitly addressing technology adoption and implementation issues in sufficient details. Communication problems and lack of feedback loops exist among various stages of technology development life cycle. Additionally, adoption and implementation issues are realy addressed up front.

TECHNOLOGY ADOPTION AND ORGANIZATIONAL LIFE CYCLE VIEW

Adoption of Technology involves various organization unit's commitments at different levels as the technology passes from the development stage to its broad usage. Figure 3 shows the commitment levels as the technology is adopted.

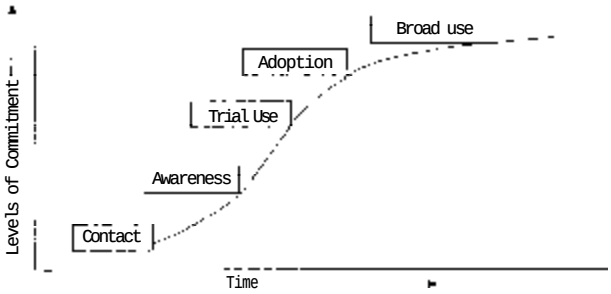

Fig. 3. Technology Adoption Curve is a time phased level of commitment for all stakeholders.

We must remember that technology maturation and adoption is a learning and knowledge transfer process. Organizations move through these stages by processing information, knowledge, and other forms of supporting evidence about the technology. Given that the technology in question meets the known or latent desire of the organization (s), it is most effective when the right information is passed on to the following organizations. For example, if the technology for drying a fruit is contemplated, then the pilot tests of the drying device(s) along with the environment must be properly planned and executed to address the concerns and, more importantly, to provide the information necessary for further decision

making. Indirect drying (such as solar heated forced hot air) may be preferable for some fruits and vegetables compared to direct solar drying, a knowledge that can only be obtained through proper testing. These information requirements differ widely in different contexts. A university researcher needs less informtion to adopt a particular tool than an industry practitioner who has to sell the product at a price and has meet a schedule. In general increasing the mechanisms available to any potential user increases the possibility of successful transition. To improve the adoption of a technology, wide-ranging information needs must be anticipated during development and maturation of the technology, and information must be effectively communicated to the right individuals at the correct time.

TRANSITION LESSONS LEARNED

Transition is a *people-to-people* process, and not a *data-to-person* issue. Researchers have determined that cognition and motivation play important roles in this process. Along with this, a structured process and methodology must be used which addresses the developer's ability to transition the technology, the user's influence on the developers to adapt to his/her requirements and environment, the user's capability and ability to change and to manage the innovation, and a proactive infrastructure that allows the producer and users to routinely work together on maturation and adoption of the relevant technologies applied to a specific application context. Lessons learned must be used throughout the entire product development to the adoption process in order to be more effective for the transition.

TRANSITION AS A LIFE CYCLE PROCESS

Viewing technology transition as a life cycle process requires addressing the transition issues across the stages of the technology maturation and adoption activities. Figure 4 shows the major development/adoption activities.

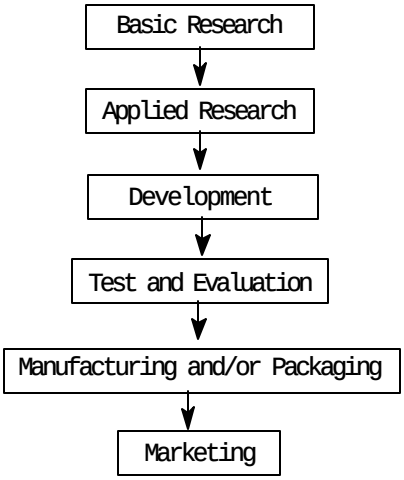

Fig. 4. Development/Maturation Activities[1] with a traditional technology development process

Figure 5 shows adoption/transfer activities normally performed in sequence.

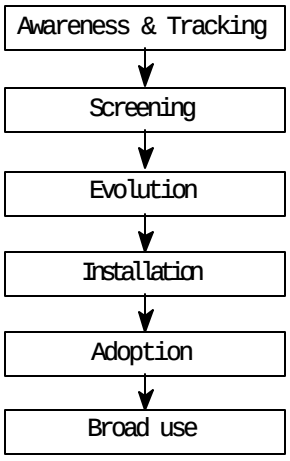

Fig. 5. Adoption/Transfer Activites[1] for a traditional technology transition process

These two sets of activities (shown in Figure 4 and Figure 5) must be accomplished

concurrently as shown (Figure 6) in order for an effective transition.

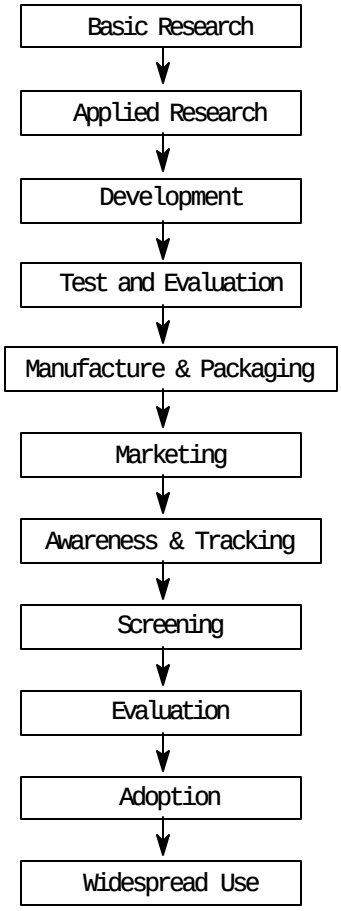

Fig. 6. Transition Life Cycle[1] with concurrent technology development and transition activities

Concurrent transition can occur only when the producers and users of technology work together. One way for this to happen is for the producers and users to form strategic partnerships to jointly solve the problems associated with developing/maturing and adopting the specific technology. Because of existing conditions and barriers to effective and efficient technology transition, the "trick" is to get this happen. Some of the actions which could be taken in this regards are discussed in the next section of this paper. An approach for getting the producers and users to work as a team to jointly solve the maturation and adoption problem is discussed also.

TECHNOLOGY TRANSITION FACILITATORS

In this section we will discuss the conditions that facilitate and also may accelerate the technology transition process.

Necessary Conditions for Technology Transition

An initial set of conditions is discussed in this section. These include : incentives for the users and producers, technology awareness, technology suitability, user readiness, producer effectiveness, ease of technology acquisition and assimilation, and managing technology maturation and transition process. These items are briefly discussed below.

a. Transition Incentives for the Users and Producers : New technology will not be used unless the potential users have strong incentives to do so. Barriers may exist in the form of : costs, uncertainty of outcomes, general inertia of using the old and tried processes, etc. Unless these issues are addressed upfront, technology transition will be difficult.

Similarly, the efforts needed to productize may not be properly compensated for the producers. Technology transition is a low priority item for some technology producers such as, universities and research institutions where most innovations are made. For them, promotions and tenure criteria emphasize publications and basic research and not widespread use of the product. Commercial organizations may not benefit through widespread use of their technology as more competition from use of "copy cat" items may cut into their profit.

b. Technology Awareness of the Users and Producers : New technology will not be used, no matter how promising or profitable it may be, unless the potential users know its existence. Similarly, the Producers may not be aware that there is a need for use of their technology. Education and training for the users and producers to improve awareness of technology can improve wider use of the technology.

c. Suitability : Unless the technology meets the user's requirements in terms of functionality, performance, reliability, scalability, extendibility and other quality factors the technology will not be used no matter how slick the gadget is. Other factors that are important to the users are :

- Experienced technology users available to support the project
- Quality documentation and easy to understand training materials
- Prior case histories of successful use of the technology
- Ease of use
- Technology provides analyses comparing it with alternative approaches
- Technology is modifiable to suit local environment
- Technology addresses the problems identified
- Technology solves the identified problems

d. User Readiness : Even when the technology is ready for adoption, the user may not be ready to use it. The personnel skills and training may be inadequate. The level of technology may be a "quantum" jump from the current practices or too radical a change. The users' culture and receptivity to accepting risks and changes associated with the technology may limit its adoption. Thorough analyses of the user's ability, culture, skills, training as well as environment should be addressed prior to pushing a technology to the users.

e. Producers effectiveness in modifying technology : Too often technology is developed in a vacuum, without any awareness of the anticipated benefits or its ease/difficulty of use. User involvement in developing a technology or users' ability to modify it to solve their needs and usability will improve the technology use.

f. Ease of Technology acquisition and assimilation : Acquiring new technology often involves high costs, and organizational barriers to its widespread use. High costs and delays associated with approval by the organization may be an impediment. Support for the new technology may be unknown, difficult to obtain or may be too costly. These barriers must be well understood and addressed to the users' satisfaction.

g. Managing technology maturation and transition life cycle : Technology development and transition is not "one-time" event. Successful technology maturation and transition requires efforts during all stages of its development, manufacturing and transition with a feedback mechanism in place. For example, a prototype may have to be transitioned into practice in order to make it scalable, robust and adoptable.

Technology transition efforts often fail when transition issues are retrofitted onto existing technology development programs. Transition related issues are often added too late in the life cycle to incorporate the necessary modifications to affect the downstream users. A proactive approach may be necessary. It may help to consider technology transition as a project with attributes of work breakdown structure, cost, schedule and milestones.

Recommended Actions to Facilitate Technology Transition :

In this section we will provide a list of action items that would, in my opinion, facilitate the transition of technology from the producers to the users and would improve widespread use of the technology.

a. Implement Life Cycle Aproach and Support for Technology Transition : In Figure 2 Technology development life cycle was presented. Take note that activities typical of technology transition consist of series of work packages, with feedbacks at each stage completion.

The proper feedback loops enable communication between the producer and the user ensuring user requirements are input into

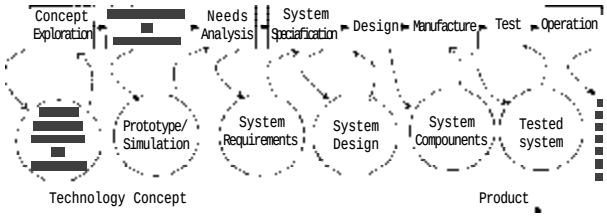

Fig. 7. Technology Transition Life Cycle model with feedback loops.

the development and manufacture of the product. This approach also builds a producer/user relationship that further enhances its chance of adoption. In order for this model to succeed, it is essential that transition plans are created when a work package is passed on to the next phase. This transition plan should establish the appropriate balance of technology capability and technology maturity of the system and would provide the initial operational capability of the technology. This plan should address the most likely areas for technology upgrades across the systems' life cycle. One must also establish the appropriate tailoring and sequencing necessary for the technology transition to succeed along with associated responsibilities and resources required for achieving the desired results.

b. Incentives for Technology Producer/ User : Identify the incentives for the developer of technology and user. If the universities and research institutions are the producer of technology, financial incentives could be provided for developing technology that have wider application, in addition to providing grants and monetary awards. This could be achieved by facilitating patent application and approval process for the researchers, and recognition of the researchers who produce more adoptable technology. If the industrial organizations are the producer of technology, they could be provided with free or low cost marketing assistance, and assured royalty income for a limited time.

Users' incentives could include training assistance to learn the technology. Other incentives could include free or low-cost marketing of the products.

c. Implement Technology Producer/User Workshops : Regularly scheduled formal interactions between the producers and users of technology can have a positive impact on the technology transition process. Such dialogue and communication amongst these two groups would provide the needed feedbacks to improve the technology as well as its adoptability to the users' requirements. Workshops and meetings should be arranged at key points of technology development and transition process so that these

feedbacks and sharing of experiences can occur in a timely fashion. Technology can be then modified if necessary based on these inputs. In addition, the workshops are excellent forums to build the camaraderie amongst these two groups. This would further ease the technology adoption process.

d. Develop Structured Approaches to Technology Transition : One of the major impediments to technology transition is that the process is not well defined or well monitored during the execution. Most technology transition efforts are either done *ad hoc* or in an almost linear fashion with no or little feedback from the users to the producers. More importantly, current practices seldom provide the necessary feedback to the decision makers throughout the technology development process. Without this, other potential users of technology cannot capitalize on the momentum gained in installing the technology. Metrics for monitoring the transition efforts are not well founded. At a minimum, alternate approaches to technology transition, metrics for maturity, adoption by the number of users, a record of number of changes made are to be measured. Some of the necessary actions include.

- Create funding and direction to research, validate existing technology transition approaches and develop alternate approaches.
- Identify organizations which can implement technology transition and their track record
- Create metrics of measuring progress
- Create metrics for successful transition
- Identify characteristics for successful transition

CONCLUSIONS

Technology transition is a systematic process that can succeed through life cycle management of its component activities, from technology only development through its use. Not only the technology should be relevant and appropriate, it must also address the lessons learned as well as organizational issues associated with all stakeholders and its intended infrastructure. The infrastructure should be carefully defined and implemented in a collaborative partnership between the technology producer and the users. In order to implement a life cycle model of technology transition, the following items are necessary : (1) Transition capability of both the producer and the user must be a continuously improving process with a well defined mechanism to incorporate the feedbacks and lessons learned. (2) A workable communication channel must be defined and implemented with producer and user collaborately solving the technology development and adoption problems. (3) The Transition Life cycle plan should be created and collaborately followed by the technology producers and the users.

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IMPACT OF EARTHQUAKE ON GEOHAZARD MANAGEMENT

Pradip Kumar Pal*

The present work attempts to present elements of earthquake parameters, earthquake zoning, effective earthquake disaster management through adequate preparedness and effective emergency management. The impact of tsunami on human life and property by the earthquake of Sunday December 26, 2004, along the Indian coasts of Andhra Pradesh, Kerala, Tamil Nadu and Pondicherry has also been discussed.

INTRODUCTION

The Indian subcontinent in general has been suffering many natural disasters. A disaster is defined as a "calamitous event bringing great damage, loss or destruction." These events can be earthquakes, landslides, floods, hurricanes, volcanic eruptions, etc. Disasters can be classified as natural, man made, geologial and ecological. Almost all disasters are accompanied by loss of property, infrastructure and life. The losses experienced vary with the type of the disaster, its magnitude and the areas affected. It is feared that the annual toll of life and damage caused by natural disasters are ever increasing though there are no comprehensive global data to prove or disprove this.

Earthquakes are natural disasters caused by earth's internal energy. Most earthquakes (seismicity) are associated with a particular kind of tectonic movements which find their expression in sudden disturbances in certain parts of the earth's crust. Since an earthquake is a short-lived phenomenon and since most damage to life and property is caused by collapes of poorly constructed buildings and habitats, the accompanying toll of life can be mitigated by suitable disaster mangement programme if the time of occurrence and location of an ensuing earthquake can be predicted with some precision. As earthquakes occur suddenly and the underlying process is poorly understood, earthquake prediction historically, enjoys no better status than alchemy in the scientific circles. A multidisciplinary approach in earthquake predicition is now becoming increasingly popular. It is often said that "earthquakes do not kill people, buildings do". Historically, this aphorism has proven to be quite true, for poor resistance to earthquate cause building collaps and serve damage, which leads to loss of life.

Earthquake is common in India (55% area of India falls under active seismic zone) due to the continuous movement of the Indian plate and its striking the Eurasian plate as well as the location of the youngest mountains chain in the form of the Himalayas. On December 26, 2004, a giant

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thrust faulting, caused an earthquake of about 9.0 Richter in the offshore regions of northwestern Sumatra (Fig. 1) It created a

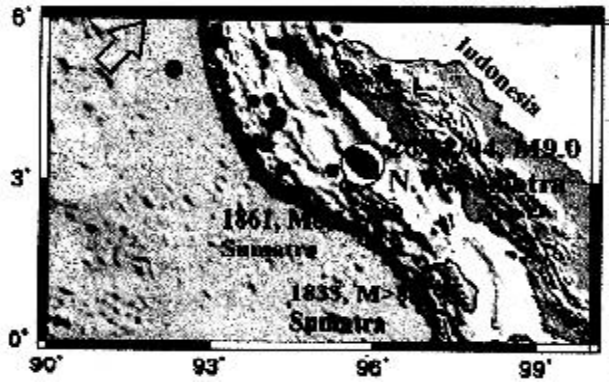

Fig.1. Location of the Sunday December 26, 2004 Earthquake

Tsunami which propagated along on to reach shores of Thailand, Indonesia, Maldives Somalia and India. Tsunami is derived from a Japanese word 'tsu' meaning a port and 'nami', a long wave. The sea waves are caused by sudden subsidence or uplift of large areas of sea floor associated with destructive earthquakes. As a Tsunami approaches a coastline, the ocean depth decreases and consequently, velocity and wavelength decrease and the amplitude increases. Huge waves so generated cause great damage along the coastline.

The last decade (1990-2000) was declared by United Nations as International Decade Of Natural Disaster Reduction (IDNDR). The focus during the decade was to shift from traditional relief distribution to the community after disasters towards preparedness and mitigation. In India alone, an average of 4,888 people are killed and 59 million affected annually from various natural calamities (World Disaster Report, 1994). The Impact of earthquakes are sudden with little or no warning, making it just impossible to predict it and take timely precautions against collapse of man-made structures. To prevent higher damages pre-disaster activities have significant role to play.

MORPHOLOGY OF EARTHQUAKES

Tectonic earthquakes occur as a consequence of the accumulation of strain due to relative motion of techtonic plates. The plates behave as rigid bodies and the plate boundaries as brittle mass. The strain released along the plate boundaries give rise to distribution of earthquakes. However, not all the earthquakes are restricted to the plate boundaries. On a regional scale it is observed that some rigid blocks which are largely aseismic are bordered by relatively softer regions having appreciable seismic activity. The ground begins to shake as soon as the rupture occurs and the basic types of elastic waves (Fig. 2) make up the shaking

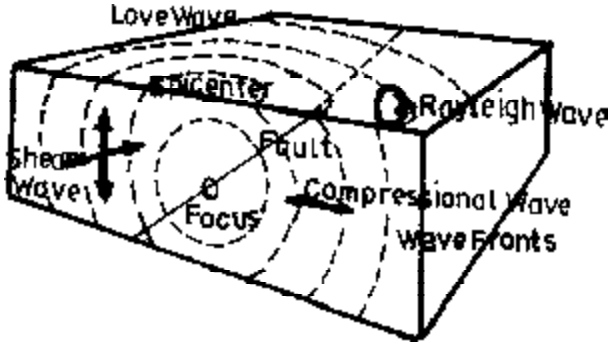

Fig.2. Earthquake Produced Seismic Waves and Random Pattern of Ground Shaking Motions

that is felt. The waves that arrive first are called 'P or primary waves' with velocities of the order of 5.5 to 8 km/sec. having compression and rarefaction vibrations travelling longitudinally

along the direction of propagation. The next to arrive are 'S or secondary waves', also known as the destructive waves, which spread the rock sideways, traverse to the direction of propagation with velocities of the order of 3.3 to 4.8 km/sec. The surface waves are two types, namely, Love waves and Rayleigh waves these are the slowest to arrive. The parameters of an earthquake are hypocenter (focus), epicenter, origin time and magnitude. Magnitude is the measure of energy released by an earthquake and is a numerical quantity determined by instruments, independent of the location of the instrument. Magnitude and intensity of earthquake may confuse and mislead the general public. Magnitude relates to quantify the energy released, whereas, the intensity is determined by the interpretation of the damage caused by the earthquakes at different places.

EARTHQUAKE ZONING

In seismically active regions, planning based on probable characteristics of earthquakes to be expected in the future is known as 'seismic hazard assessment'. Seismic hazard may be definied as the probability of occurrence of potentially damaging seismic soil motions at a certain site within a certain time interval. The process of determining seismic hazard in a region is called 'seismic zoning'. Local soil conditions can influence the seismic soil or ground motions and knowledge of this leads to 'seismic microzoning'. The main outcome of a seismic zoning procedure are zoning maps displaying a quantity related to the assessed frequency and severity of shaking due to expected future earthquakes.

Seismic zoning map of a region divides it into several zones on the basis of recorded, seismicity. Each zone represents the same order of seismicity and charateristic of a future earthquake can be well predicted in such zones. These maps provide guidelines for cost effective design in mitigating the damage due to earthquakes. Seismic zoning of a country region is updated regularly as more data become availble and the underlying complex process is better understood.

Seismic zoning of a particular region is done in three stages[1] namely, estimation of intensity, construction of isoseismal and mapping the envelopes of different degrees of intensity by superposition of isoseismal of individual earthquakes. Parameters such as tectonics, geomorphological and soil conditions of the region etc. control the last step. Such stages

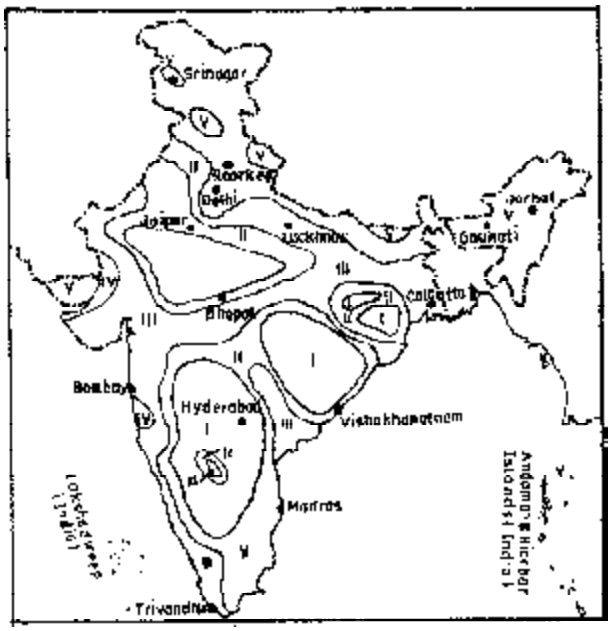

Fig.3. Earthquake Zoning Map of India (IS : 1893–1984)

giving rise to landslides are most valuable geomorphological forms. Fig. 3 shows seismic zoning map of India, 1984 (IS : 1973–1984).

The modified Mercalli intensity associated with various zones is given in Table-1.

Table 1 : Modified Mercalli Intensity Associated With Various Zones Of India

Zone	Intensity in MM Scale	Observed effects
I	V or less	Awakening
II	VI	Frightening
III	VII	Damage to buildings
IV	VIII	Destruction to buildings
V	IX or above	General damage to grade destruction of Building

PREPAREDNESS MEASURES FOR EARTHQUAKES

For effective management of earthquake situations, we have to adopt[2] (i) long term preparedness plan, (ii) medium term preparedness plan and (iii) short term preparedness plan. The long term measures typically require a sufficiently long period for implementation. The result output under long term measures is in the form of complete protection of the community and public utility structures from calamity. This may require 10-20 years for implementation of the strategy for the best results in the case of earthquake disaster mitigation. The medium term measures require a smaller time period (only five-year plans) with an objective of severity reduction. The medium range measures may vary from few months to few years for complete implementation of the streategy. The short term measures can be taken up immediately in the high risk areas. Earthquake disaster management can also be divided into pre-disaster phase, during and short-time after disaster phase or emergency phase and post disaster phase as shown in Table-2. Traditionally, disaster management was confined to the distribution of relief in the affected areas. Yet, for effective earthquake disaster management, all the above phases mentioned in Table-2 should be taken care of.

Table 2 : Preparedness Measures for Effective Earthquake Disaster Management

Predisaster Phase	Emergency Phase	Postdisaster Phase
l Awareness Campaigns l Earthquake resistant construction l Training l Development of emergency action plan	l Communication network l Restriction on VIP visits and local sympathsers l Rescue operations l Emergency/ Temporary shelters for survivors l Distribution of relief materials l Medical aid l Coordination l Transparency l Media watch	l Community Participation l Economic rehabilitation l Social rehabilitation

EARTHQUAKE DISASTER MANAGEMENT

The philosophy of earthquake resistant design is to enable most structures to resist minor earthquakes without damage, resist moderate earthquakes without significant structural damage, but with some non-structural damage, and resist a major earthquake without collapse

or loss of life. The disaster caused by earthquakes cannot be completely avoided but can be greatly minimized by using technical knowledge. For this, special care is required to translate the complex technical language to a language understandable by the common people. Though a good deal of research on earthquake prediction is being carried out in many developed countries, the present status of earthquake prediction is still in a research stage. Meaningful prediction means the name of the place, time and magnitude of earthquakes. The prediction of earthquake occurrence could be useful for safety of human lives ; it may not however be useful in the safety of man-made structures. From the past earthquakes, it is clearly seen that the man-made structures suffer maximum damage in earthquake causing economic losses to individuals, community and the Government. Based on the available data and expected maximum intensity of earthquakes in the different parts of the coutry, a seismic zone map of India was standardized in 1984 (IS : 1973–1984) as given in **Fig. 3**.

The recent earthquake of magnitude ($M \approx 9.0$) that occurred in the offshore regions of northwestern Sumatra on December 26, 2004 with devastating effect on human life and property was not restricted to a single country. The large tsunami waves, reaching a height of 20 metres in certain areas, caused by this earthquake, affected the coasts of Thailand, Indonesia, Maldives, Somalia and India. The Andaman-Sumatra section of the subduction zone had produced many large and destructive earthquakes in the past, some of which have also generated destructive tsunamis. Table–3 indicates, briefly, the impact of tsunami along the Indian coasts of Andhra Pradesh, Kerala, Tamil Nadu and Pondicherry.

Table 3 : Impact of Tsunami due to Earthquake on December 26, 2004 (Sunday) along Indian Coasts.

N. B. Data presented here are from the survey of the local tsunami victims and also from the electronic media available so far.

Parameters	Andhra Pradesh (about 112 persons dead)	Kerala (about 170 persons dead)	Tamil Nadu (about 80000 persons dead)	Pondicherry (about 700 persons dead)
Length of coast affected	985 km	250 km	1000 km	25 km
Incursion of water into land	500 m to 2 km	1 km to 2 km	1 km to 1.5 km	300 m to 3 km
Average height of waves	2 m to 5 m	3 m to 5 m	7 m to 10 m	8 m to 10m
Villages affected	305	190	380	40
Population affected	2.15 lakhs	2.5 lakhs	7 lakhs	45,000
Dwelling units affected	1,570	11,840	1,15,000	11,000
Cattle lost	200	nil	6000	700
Cropped area hit	800 ha	nil	2,600 ha	800 ha

The effective earthquake disaster management can be achieved through adequate preparedness, effective emergency management and by rehabilitating the communities affected by disasters. The approach of the earthquake management should interlink the various

aspects of management and administration. Thus, when determining the seismic risk involved for a given building, four factors must be considered : (i) hazard, (ii) exposure, (iii) vulnerability and (iv) location. The preparedness phase should be linked to the rehabilitation of the community while preparation to face the next earthquake in the rehabilitation/ reconstruction stage itself should be started. Hence, earthquake disaster management can be divided into three broad stages as pre-disaster phase during and short time after disaster phase or emergency phase and the post disaster phase.

ACKNOWLEDGEMENT

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DO YOU KNOW?

Q1. How do butterflies taste?
Q2. How much fish is consumed annually by mankind?
Q3. Can a cow climb stairs and go down stairs?
Q4. On an average, how much does a crawling baby crawl per day?
Q5. Where do you have four seasons each 40 years long?
Q6. In irrigation how much water is required to produce 4 kg of rice?

FAMILY & CLASSROOM ENVIRONMENT OF DRUG ADDICTS

Ravi K. Gunthey* and Manisha Jain*

Present investigation attempts to study the Family environment and classroom environment of drug user, college students of two Indian states, Gujarat and Rajasthan. Hindi adaptations scale to measure effects of family environment and classroom environment as independent factors. Results represented significant difference between the two groups of students. This may be due to the different social and cultural pattern of Gujarat and Rajasthan States.

INTRODUCTION

During the last decade, a marked increase in the use of psychoactive or mind altering drugs is seen in the society, particularly, among the youth. Concurrent with their rising use, has come their misuse as well. The misuse of a drug may take the form of dependence or abuse. Drug abuse is a puzzling form of behaviour. Recreational drug use after all carries considerable risk of harm and long term drug abuse usually undermines a person's physical and psychological health. People turn to drugs in the hope of finding oblivion, peace, expanded consciousness, or euphoria. The fact that few drugs actually produce the effects for which they are taken–or if they do, they do so for only a brief time, seems not to discourage many.[1] Drugs have multiple effects that vary with the amount of drug used and the personality of the user, as well as the user's expectations of the drug's effects. Whether or not a person decides to use drugs to solve problems, to obtain a pleasurable experience, or to reduce unhappiness depends on his or her background, present environment, and the availability of the drugs.

The young addicts report that their parents hardly have any time for them. This may not be directly linked with addiction but certainly could be a factor of family alienation and hence, indirectly responsible for addiction. Drug habit of elders and particularly of parents is an important factor for the status-imitation for the child and father's habit in particular, influence the male children.[2,3] Few studies indicated that the frequency of parental substance use was positively related to adolescent substance use, while string family bonds and parental support were negatively related.[4] Education seems to have a direct retrogressive correlation with addiction in the sense that it does not necessarily influence initiating the use of a drug but those who get addicted gradually become dropouts and do not continue their education, careers of even the most dedicated and determined students can be thus sabotaged.[5] Higher levels of social dysfunctions (e.g., low educational achievement, few job skills,

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poor work histories and limited interpersonal coping networks) have also been observed among the addicted students.[6,7]

METHODS : Subjects

Participants in this research were 40 drug addicted undergraduate and post-graduate college students of Gujarat and Rajasthan States (20 from each state) in the age range of 18-25 years. Monthly income status of their families was similar (below Rs. 10,000 per month in Indian currency). All the subjects belonged to Hindu family.

Procedure

The subjects, thus matched on income, education and caste factors were individually interviewed with structured questionnaire.

Measures

The psycho-social scales for this study were chosen on the basis of their item wise inter-correlations and reliabilities (family environment,[8] classroom environment[9]). The measures were mostly adaptations of existing scales. The measures had adequate psychometric properties and were found to be reliable and valid. The measures of family environment scale were grouped into three dimensions. : Relationship Personal Growth and System Maintenance while the measures of classroom environment scale were grouped into four dimensions of Relationship, Personal Development, System Maintenance Dimensions and System Change.

STATISTICAL METHODS

The significance of differences in the family and classroom environment of the two groups of students was tested by statistical t-test.

FINDINGS

Table–1. Family Environment Scale Scores of Drug users of Gujarat and Rajasthan, Mean ± SD

Family Environment Scale	Gujarat	Rajasthan	t
Cohesion	17.30±4.03	10.10±2.05	7.13***
Expressiveness	16.30±3.51	14.25±1.48	2.41*
Conflict	15.70±4.16	17.60±2.13	1.83
Independence	16.70±4.26	12.25±1.04	4.59***
Achievement Orientation	17.25±3.55	13.85±2.35	3.58***
Intellectual-Cultural Orientation	16.55±3.67	10.60±1.39	6.84***
Active-Recre-ational Orien-tation	13.75±4.12	11.25±1.41	2.58*
Moral-Religi-ous Emphasis	17.40±2.76	12.20±2.04	6.75***
Organisation	16.75±3.01	6.75±3.79	9.26***
Control	16.80±4.19	19.75±1.34	3.01**

*P≤ 0.05 ; **P≤ 0.01 ; ***P≤ 0.001

Table–2. Classroom environment scale scores of drug users of Gujarat and drug users of Rajasthan, mean ± SD

Classroom Enviroment Scale	Gujarat	Rajasthan	t
Involvement	22.65±5.69	12.35±4.19	6.52***
Affiliation	19.70±5.06	15.70±2.35	3.20**
Teacher Support	18.00±4.31	10.95±2.06	6.65***
Task Orientation	20.90±3.83	16.80±1.91	4.27***
Competition	14.90±2.49	11.35±1.82	5.14***
Order and Orga-nization	13.80±4.29	10.60±2.27	2.94**
Rule Clarity	17.85±4.75	20.40±3.98	1.85
Teacher Control	18.60±3.67	19.25±1.95	0.69
Innovation	15.25±3.63	11.05±2.04	4.52***

*P≤ 0.05 ; **P≤ 0.01 ; ***P≤ 0.001

FINDING

We compared the family environemnt and classroom environment of drug users of Gujarat with that of Rajasthan. Fewer than 5% of these measures were not significant, which suggests a chance finding. By t-test, we compared the drug users of both the states on various subscales of the two inventories. **Tables 1 and 2** show the means and standard deviations (SD) for the scores of the addicted students of the two states on each of the sub-scales.

As shown in Table–1, the drug users of Gujarat differ significantly on subscales like cohesion, independence, achievement orientation, intellectual-cultural orientation, moral-religious emphasis, organization and control from the drug users of Rajasthan. The drug users of Rajasthan were more aggressive, tend to break more rules and regulations of family whereas the drug users of Gujarat were found to be more helpful by nature ($t = 7.13$, $df = 39$, $p \leq .001$), were extrovert and expressed their feelings directly, were more assertive and able to make their own decisions ($t = 4.59$, $df = 39$, $p \leq .001$) were more competitive ($t = 3.58$, $df = 39$, $p \leq .001$), participated actively in social and recreational activities ($t = 6.84$, $df = 39$, $p \leq .001$). The drug users of Rajasthan were found to be less interested in social, religious and cultural activities ($t = 6.75$, $df = 39$, $p \leq .001$). They were not able to make their own decisions and were less competitive. The drug users of Gujarat showed clear organization in planning family activities ($t = 9.26$, $df = 39$, $p \leq .001$).

Table–2 illustrates that the drug users of Gujarat had attentive interest in class activities ($t = 6.52$, $df = 39$, $p \leq .001$), were friendly, calm, obedient and communicated easily with teachers ($t = 6.65$, $df = 39$, $p \leq .001$). The drug users of Rajasthan were found to be more introvert, did not enjoy working together, were not interested in planning classroom activities ($t = 4.52$, $df = 39$, $p \leq .001$), were not task oriented ($t = 4.27$, $df = 39$, $p \leq .001$) and competing with each other for grades and reognition ($t = 5.14$, $df = 39$, $p \leq .001$). The drug users of Gujarat were found to be more interested in organization of assignments.

DISCUSSION

Social and family influences predominate drug use of youths. It typically starts among a group of friends or relatives. Drug use among family members presents a powerful message that "substance" use is an acceptable behaviour. But it becomes a matter of great social concern, possibly because drug abuse is so often concomitant with impulsive, acting out behaviour of other kinds.

During the abusive stage, students increase both the frequency and amount of use. They become increasingly preoccupied with their drug of choice and begin using "substances" at unpredictable times, often when they are alone. Trouble at home is also expected when young adults abuse "substances". The abuse becomes a family disease, and all members of the family become involved either directly or indireatly with the abuse.[10] Abusing students are frequently absent from classroom, and some drop out of college altogether. Others are pushed out of college because of their involvement with classroom disruptions and/or ongoing absenteeism.[11]

In some states of India, use of drug like opium on family rituals and social occasions like birth, marriages, death, worshipping certain deities, etc. is a very common phenomenon, being a component of local cultural tradition. Sometimes it is customary to offer opium to one's friends, relatives and guests as part of hospitality and courtesy. Consequently it can be said that drug exposure begins more as a social than a secretive habit in some parts of the country. To draw attention to the impact of culture, among other things, is the objective of this study. The results of the present study indicate that there were a number of differences in psychosocial behaviour between drug users of Gujarat and Rajasthan due to different social and cultural pattern of both the states. Hence, "addiction" is not merely a problem of personal deviant behaviour, but has a cultural connotation as well. Further research in this light might develop realistic strategies solutions to problems of dropouts among college students.[12]

Despite these methodological caveats, the following findings emerged : (1) differences were found between the two groups on some factors of family environment and on some factors of classroom environment due to different social and cultural pattern ; (2) drug abuse among college students cannot be eradicated as a whole, but need to be looked at separately : by educational programmes, by providing them more facilities, by solving their problems, by changing their present environment etc.

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ALL'S WELL THAT CORRODES WELL

Sujit Kumar Roy*

Corrosion is perceived commonly as a process of degradation of a material in contact with its environment. Molten aluminium is a strong corrosion agent as it enters into chemical reaction with a variety of materials. However, this underlying principle of a corrosion reaction can be utilized to devise a way to synthesize an interesting set of composites. The process has been called 'reactive melt penetration' and the resultant material is an interpenetrating phase composite. A brief review of this process, characteristics of the products and future possibilities is presented.

INTRODUCTION

Aluminum and its alloys have by far the largest production figures for non-ferrous metal production around the world, and the figures are still increasing. Molten aluminium is one of the most aggressive corroding agents due to its high affinity to oxygen and its ability to dissolve a great number of materials. The question of suitable refractories for such light-alloy processing is, therefore, of great significance. Many refractory compositions have been tested for molten aluminium contact, with varying success and limitations. Reactions between silica and/or mullite and molten aluminium have been an issue in the foundry industry for a long time. K. J. Brondyke[1] of Aluminum Corporation of America (ALCOA) first showed that exposure of commercial aluminous refractories containing as little as 1% SiO_2 to Al-melt caused severe chemical attack that formed alumina and metallic silcon. The latter dissolved in the aluminium influencing its properties. Other researchers found that the interactions in the Al-SiO_2 system affected the reliability of integrated circuits and performance of metal-oxide semiconductor devices.

Corrosion is, generally, seen as a process of degradation of a material in contact with a reagent and not explored as a technique for synthesis of composites. In the early nineties, Breslin and his team[2] at the Ohio State University, USA, first used this reaction to develop a novel fabrication route for an interesting Al_2O_3/Al composite having interpenetrating network of both the phases. He termed this technique as "reactive melt penetration" (RMP) process. Similar investigations were carried out afterwards in the USA, Europe, and Asia[3].

Aluminium oxide is one of the most important engineering materials, because of its excellent properties and low cost. Good high temperature stability, adequate thermal and electrical insulation, appropriate resistance to corrosion, high strength and high wear resistance are some of the attractive features of alumina ceramics.

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However, there is a shortcoming. Because of the absence of any plasticity they do not deform like the metals and have poor shock resistance. Brittle ceramics, they exhibit linear elastic fracture behaviour when stressed. That is, when the fracture stress is exceeded, it fails with no extra energy required. The failure is instantaneous and is called a catastrophic failure. An alumina ceramic may be brittle but is not necessarily a weak material. The high energy of the Al–O ionic bond and close packing of the ions make alumina an exceptionally strong material. The elastic modulus of aluminium oxide ceramics at room temperature is nearly 400 GPa while that of aluminium is just about 70 GPa and steel has this value at 187GPa. Alumina's brittle natures has imposed limitations on its use, but owing to interesting high-temperature properties and wear characteristics, great efforts have been made to improve properties such as toughness, thermal conductivity, and thermal stress resistance. One possible approach is to make composite materials by introducing other materials into alumina, thus strengthening the microstructure of the monolithic ceramics.

CERAMIC COMPOSITES

A composite material consists of at least two chemically different materials separated by distinct interface. The constituents are combined three dimensionally on a macroscopic scale to form a useful material. The advantage of composites is that they usually exhibit the best qualities of their constituents and often some additional qualities that neither of the component phases possesses. Ceramics have high specific modulus, good thermal and chemical stability, and good corrosion resistance whereas metals generally have high resistance to fracture and good thermal and electrical conductivity. The combination of a ceramic and a metal in a composite structure may help in realizing the desirable properties of both and in tailoring the composition and properties to specific applications.

Production of ceramic-metal composites (CMC), however, involves creation of interface between dissimilar materials – a ceramic and a metal. As a consequence, a set of disturbances occurs at the interface that significantly affects the properties of the product composite. There is some abrupt spatial discontinuity in materials, properties at the interface, the nature of which has been the subject of considerable research. Learning how to control and to tailor the properties of the interface is the ultimate objective of composite forming techniques. The discontinuity is manifested in a variety of ways that may differ in importance according to the application. Generally, there is a lattice mismatch between a ceramic and a metal, and a lack of thermodynamic equilibrium. Therefore, they tend to react at high temperatures to form reaction products. The atomic bonding changes from predominantly ionic or mixed ionic-covalent in a ceramic to metallic in a metal. Mechanical and thermal properties also vary and the appreciable difference in the coefficients of thermal expansion (CTE) and thermal conductivities between the members of a CMC may result in residual strain in the resulting material. The properties of a composite will depend on how best the various discontinuties are accommodated.

It is well known that the incorporation of ductile phases such as metal reinforcements

improves the toughness of brittle ceramics. Toughness is measured in terms of the amount of energy required to fracture a material and increased toughness signifies an improvement in their resistance to failure. The strength of a material, on the other hand, is determined by the stress needed to break it. In many circumstances toughness will be more important than tensile strength as a criterion of suitability of a material. Ceramic composites comprise one class of materials that exhibit desirable combinations of high specific modulus, high toughness, thermal stability and good resistance to corrosion that are essential for many advanced applications. The physical properties of a composite are extremely sensitive to volume fraction of its components, especially at the regime of the percolation limit. This is a critical volume fraction at which particles become interconneted three dimensionally across a composite. It means that at the percolation limit, the distributed particles are sufficiently in contact as to allow continuous pathways to exist throughout the matrix. Theoretical calculations have shown that a minimum phase content of 16% by volume constitutes a percolation threshold. In practice, however, much larger quantities of the desired phase needs to be used. The porous Ni/YSZ (yttria stabilized zirconia) cermets (= ceramic + metal) that function as anode in SOFC (solid oxide fuel cell) device contain 30–40 volume% nickel.

A fuel cell is an electrochemical device where the chemical energy of a fuel such as hydrogen is converted into electricity by electrochemical oxidation of the fuel. The only by-products of this process are water and heat. The percolation threshold for the conductivity of Ni/YSZ cermet is at about 30 vol% metal. Below this threshold, the cernet exhibits predominantly ionic conducting behaviour. Above 30vol% nickel, the conductivity is about three-orders of magnitude higher, corresponding to a change in mechanism to electronic conduction through the metallic phase. For this porous cermet, processing variables such as porosity, pore size and its distribution, and size of the initial particles as well as connectivity of each constituent component influence the percolation threshold. The electrical behaviour of Ni/YSZ cermets is, therefore, a strong function of these factors.

The presence of a percolative path of a dense monolith is dependent on many factors that include the size, shape and dispersion of the filler phase and the properties of the composite are only to a certain extent related to the concentration of the dispersed phase in the ceramic matrix. By varying the concentration of the filler, properties can be modified and effectively controlled to meet certain design parameters. This 'tuning effect' is utilized in applications such as piezo-resistors and both positive and negative temperature coefficient resistors. When composite materials show electrical resistivity behaviour with temperature coefficient, devices sensitive to temperature variation can be built. If the material shows non-linear current-voltage behaviour in the percolation region, varistors can be produced. The design of composites thus involves the issues of material selection and relative abundance of the phases. When each phase spans or percolates throughout the microstructure in a composite, the interpenetrating phase composite (IPC) results.

INTERPENETRATING PHASE COMPOSITES

In the composite family, Interpenetrating Phase Composites (IPC) constitutes an interesting group that is attracting considerable attention recently[4]. These composites have also been variously referred to as co-continuous, bi-continuous and C[4] (co-continuous ceramic composite) composties. Traditionally, composites are descrbed in terms of a matrix, the continuous phase, and the particulate or the dispersed phase. In such composites only the matrix phase is spatially continuous, whereas an interpenetrating phase composite has at least two phases that are each connected in three dimensions and construct a topologically continuous network throughout the microstructure. The term "matrix" is somewhat confusing when applied to interpenetrating composites since both the phases are three-dimensionally continuous. However, it is still widely used to define the phase that has the highest volume fraction in an interpenetrating phase composite. An IPC contains no isolated phases. If any of the constituent phases were removed, the remaining phase(s) would maintain the geometry without collapsing the structure.

Materials possessing an interpenetrating phase microstructure are fairly abundant in nature. The bones in animals and humans and the trunks and twigs of many plants and trees are examples of co-continuous phase microstructure. However, only very few are there that are synthetic. Certain materials, for example, "Vycor" glasses produced by Corning, USA (spinodal SiO_2 – B_2O_3 glass system), ZnO-based varistors (polycrystalline ceramics containing continuous grain boundary phases) and some of the carbon-carbon composites incorporating carbon textile etc. constitute a group of synthetic composites having interpenetrating phase microstructure.

IPCs constitute a new set of composites and possess some physical and mechanical properties that are evidently different from and often superior to conventional fibre-or particle-reinforced composites. The ceramic-metal IPCs are comprised of two interpenetrating continuous networks, one of a ceramic phase and one of a reinforcing metal. Some promising advantages are expected from the interconnetivity of phases : an interpenetrating microstructure could yield truly multifunctional materials as each phase contributes its own properties to the macroscopic properties of the composite. Two differing properties, for example, wear resistance or rupture strength and electrical conductivity may by optimized in the same material.

The shape and spatial arrangement of the reinforcing phase are important parameters that govern composites' performance in service. One of the difficulties in fabricating IPCs is controlling the 3D-microstructure that is formed and it is, therefore, also important to be able to characterize the interconnected nature of the phases in the composite. The distribution of the phases and their spatial continuity in an interpenetrating composite is difficult to describe. 'Connectivity' suggested by Newnham[5] is a practical concept for describing the spatial arrangement of each phase in such a composite since it gives the number of dimensions in which component is self-connected. Connectivity is a key feature in property development in multiphase solids since physical properties can change by many orders of magnitude depending on the manner in which the connections are

made. Each phase in a composite may be self-connected in zero, one, two or three dimensions. For binary composites, ten (10) different connectivities, namely, 0-0, 0-1, 0-2, 0-3, 1-1, 1-2, 1-3, 2-2, 2-3, and 3-3 are possible. A 2-1 connectivity pattern, for example, has one phase self-connected in two-dimensional layers, the other self-connected in one-dimensional chains or fibres. Considering their phase connectivity in three dimensions, IPCs are designated 3-3 composites under Newnham's nomenclature while the particulate composites are termed 0-3 composites. In heterogeneous materials containing more than two phases, the connectivity patterns are basically similar to the biphasic patterns, but far more numerous. The connectivity values are 20 and 35 for three-phase and four-phase composites, respectively. In order to correlate the properties of an IPC with its microstructure, which is often needed for design and also for its practical application, it is necessary that the features of microstructure be expressed in the quantitative terms. Quantification of a microstructure is not an easy task, especially where it concerns an IPC. There are the very few investigations that provide any quantitative information regarding the interconnected nature of the composite products. Serial sectioning of the microstructure and computational image reconstruction has been used to evaluate the 3D-nature of the phases. A few investigators used the technique of X-ray micro-tomography to generate 3D images of composite materials. However, these facilities are not readily available in many materials laboratories and the scale of microstructure is needed to be large for this technique to be effective. Thus, there is a need for simple and rapid methods to provide quantitative information on the nature and connectivity of the phases. The concept of "contiguity" offers a practical solution to ascertain in quantitative terms the connectivity of the constituent phases in the composites. Contiguity determines the fraction of internal surface of a phase shared with other grains of the same phase in a composite. The contiguity of a phase varies between 0 and 1 as the distribution of one phase in the other changes from completely dispersed to a fully agglomerated structure. The interfacial areas can be experimentally determined using a simple method of counting intercepts with grain and phase boundaries on a polished 2D-microstructure and the phase contiguity can therein be obtained. Theoretical contiguity values may be calculated from the grain size ratio of the two phases constituting the composite and their relative abundance.

COMPOSITE FABRICATION

Making of ceramic matrix composites is more difficult than making monolithic ceramics. Structures having complex shapes and tight tolerances may be desired. Fully dense composites are generally preferred out of considerations of stress concentrations and environmental vulnerability. At present, several processing techniques are available for the fabrication of conventional dispersed phase composites. Here, the reinforcing phase is prepared separately prior to the composite fabrication, and the resultant composite consists of a matrix phase whithin which a second phase is randomly distributed. Moreover, only limited quantities of the second phase can usually be

incorporated. The favoured route for fabrication of ceramic matrix composites is pressure-assisted infiltration of a molten metal into ceramic shapes having interconnected porosity. In this process, a molten metal (or alloy) is introduced into a porous ceramic preform, utilizing either inert gas or a mechanical device as a processing medium, where high pressure is maintained till the infiltration and solidification of the metal melt is completed. Sol-gel processing and sintering/hot pressing of pre-mixed powders are alternate methods.

New opportunities for creating ceramic/metal IPCs with a highly regular architecture and tailored properties exist through the recent development of solid freeform fabrication techniques. Complex three-dimensional (3-D) ceramic forms can be fabricated in a layer-wise manner by fused deposition and direct-write methods. Direct-write methods, such as robocasting, ink-jet printing, and micro-pen writing involve layer-by-layer assembly using suspensions having high concentrations of colloidal particles.

However, each fabrication technique has its own advantages and limitations. A few of these are related to the occurrence of residual porosity, surface contamination and uneven distribution of reinforcements, poor wetting of the reinforcements by the metal, overcoming the interfacial reaction between the reinforcements and the matrix, scaling up of the process for industrial utilization, and processing cost.

The principal difficulty in the fabrication of interpenetrating phase materials is ensuring the requisite connectivity and spatial dispersion of the different component phases. Scaleable, low-cost methods for fabricating dense, shaped composities possessing desired properties need to be developed, in order to allow for more widespread commercial use of these materials (e.g., in automotive, aircraft, or energy production applications).

REACTION-BASED TECHNIQUES

Mixing of dissimilar materials such as the reinforcements and the matrix phases may lead to interfacial reactions during service at high temperatures, due to the lack of a thermodynamic equilibrium between the phases. The interfacial reactions may produce unwanted phases at the interface leading to premature failure. On the other hand, reinforcement phases that are thermodynamically compatible with the matrix can be produced in situ by reaction-based techniques where the second phase is formed by controlled chemical reaction during processing. The promising methods are the Directed Metal Oxidation (DMO) and the Reaction Bonding of Alumina (RBAO). In the directed metal oxidation (DMO) process, co-continuous Al_2O_3/Al composites are produced by the capillary penetration and oxidation of a molten Al alloy into porous ceramics. Generally, alloying elements such as Mg, Zn and Si in amounts of 8 to 12% are added to aluminium to facilitate oxidation of Al and growth of the composite. The RBAO-process shows some similiarity with the formation of DMO ceramic composites and involves oxidation of a high density, homogeneously compacted Al/Al_2O_3 powder shape, followed by sintering. To produce co-continuous Al_2O_3/Al composites of large dimensions by these methods, relatively long times and relatively high firing temperatures

(nearly 1500°C) are required. And the use of low-melting Al or Al-rich alloys imposes severe restrictions on their use temperatures. Reactive Casting of Ceramic Composites (r-3C process) utilizes a combination of rapid infiltration and subsequent reaction of molten Al (or Al alloys) within porous monoliths and produces composites of Al_2O_3/metal alloy (or aluminide phases) with higher solidus temperatures and material value. When the reaction is completed during post-infiltration heat treatment, then the rate of reaction is essentially independent of the size of the desired part. Furthermore, by utilizing thermite reactions between Al and the oxide components of a preform, the applied processing temperatures and times required for full conversion can be relatively modest.

An innovative method developed by Breslin[2] skillfully utilizes the phenomenon of corrosion of ceramics by metal melts at elevated temperatures to establish a route of Al_2O_3/Al-IPC synthesis. The process is based on a displacement reaction between a silica precursor and molten aluminium. Displacement reactions are phase transitions whereby two or more elements or compounds react to produce new products and these product phases are thermodynamically more stable than the initial ingredients. Displacement reaction can yield ceramic matrix composites–both conventional composites with dispersed phase as well as interpenetrating phase composites–in a process where the constituent phases are grown together during a reactive phase transformation. It is also thought that both composition and morphology can be manipulated to some degree in order to tailor composite structures. Processing by displacement reactions allows the in situ growth of reinforcements in the composite resulting in materials with unique combinations of constituent phases. Near net-shape composites can be obtained by appropriately selecting the reactants and the processing parameters, taking care to minimize the volume changes resulting from the reaction. A number of composites for structural applications, namely, molybdenum boride-and titanium boride-reinforced $MoSi_2$ matrix composites have been produced by this method. Ni-Al alloy/Al_2O_3 composites with an interpenetrating microstructure have also been processed by a reaction between NiO and Al.

The diverse methods for the fabrication of interpenetrating composites can have two broad goals : (i) to prepare a monolith with open porosity and then to infiltrate it and attain final consolidation ; and (ii) to synthesize the composite in situ by a chemical reaction-based method that leads to an interpenetrating microstructure. The former is widely applicable to a range of ceramic, polymer and metal systems while the latter is restricted to a limited set of materials. Much of the interest in ceramic/metal interpenetrating microstructure has been the toughening of ceramic by additions of low cencentration of a metal phase ; therefore, the composites containing nearly 60% or more ceramic are mostly sought after. Many metals have been considred of which the light metals offer the greatest potential in terms of strength-to-density ratio. Owing to its low cost and ease of fabrication, aluminium has been widely accepted. The Al_2O_3/Al system is one of the most favoured ceramic/metal-IPC materials. The advantage of the Al_2O_3/Al composites is the fact

that the Al_2O_3 matrix decides the thermo-mechanical behaviour, i.e. wear and oxidation resistance, high temperature strength, etc., and the metal phase improves the toughness by crack bridging. Crack bridging means that the metal linkages (or ligaments) extend perpendicularly over a crack, making crack propagation more difficult. Only the brittle phase is broken by the extending crack, leaving the metal linkage connecting the two parts. This increases the fracture toughness substantially. Also, the material no longer exhibits linear elastic behaviour at high stress. A propagating crack encounters increasing resistance as it advances.

SYNTHESIS OF AL_2O_3/AL-IPC

The procedure consists of the preparation of the silica shape, melting of commercially pure Al, immersing the pre-heated silica shape into the molten Al-pool, soaking at the temperature, withdrawal of the reacted shape, and removal of the adherent Al-metal for finishing. A variety of techniques may be used for preparation of silica shapes. The common glass shaping methods like pressing, drawing, blowing, etc., or using the ceramic forming techniques of cold forming and sintering can form these. Although silica is the preferred precursor for the synthesis of interpenetrating Al_2O_3/Al composites, virtually any silicate and a number of other oxides can be used. The use of different aluminosilicates incidentally results in composites with different phase contents. It is also possible to insert into the precursor composition a second phase to tailor some characteristics of the final product.

The processing temperature is significant. If processing is conducted at temperatures more than 1000°C, an excellent balance of properties is exhibited. These properties are associated with the microstructure of the resultant composite, which consists mainly of the α-Al_2O_3 and Al phases. It is found that, when processing is effected at lower temperatures, the evolution of microstructure involves the formation of transition Al_2O_3 on a very fine scale. The properties associated with this form of microstructure are inferior to those of the α-Al_2O_3 phase. Sufficiently long reaction times are chosen to ensure complete conversion of the silica preform to an Al_2O_3/Al-Si composite. The reaction is carried out in air. Although the details of the transformation are complex, the overall reaction for composite formation may be represented as follows :

$$3\,SiO_2 + 4Al = 2Al_2O_3 + 3Si. \quad \ldots\ldots\ldots (1)$$

This reaction is associated with volume shrinkage of nearly 30%. It has been suggested that the volume decrease is responsible for the formation of a porous alumina skeleton and, therefore, the interpenetrating microstructure in the product composite. Based on the tensile-cracking mechanism occurring between the ceramic and metal phases, an interesting scheme of synthesis has been forwarded, as shown in Fig. 1. On contact with the liquid Al, a thin layer of alumina forms of silica shape and cracks appear due to the accompanying volume change. Through these cracks molten Al infiltrates and reaction progresses to yield an interpenetrating composite. The success of the formation of an interpenetrating composite depends largely on the proper control of the processing parameters, because transformation kinetics, microstructure, as well as physical and

mechanical properties of these materials all vary with processing variables.

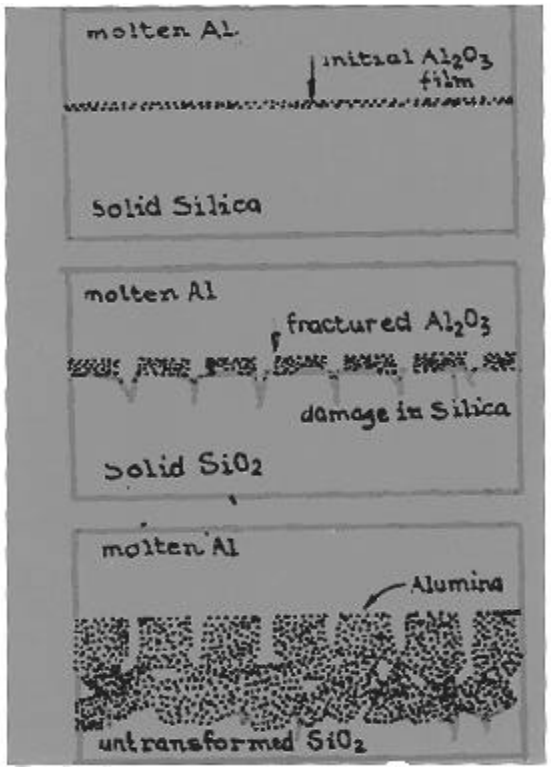

Fig.1. Schematic diagrams show the formation of Al_2O_3/Al composite by a displacement reaction between SiO_2 and Al-melt.

(a) Formation of incipient Al_2O_3 layer ;

(b) Growth and cracking of Al_2O_3 layer allowing access of Al-melt to SiO_2 ;

(c) Reaction continues to form interpenetrating Al_2O_3/Al composites.

FEATURES OF AL_2O_3/AL INTERPENETRATING COMPOSITES

Bi-continuous Al_2O_3/Al composite has good electrical and thermal conductivity and also fair compression strength because of the interconnectivity of both alumina and aluminium phases. Some physical and mechanical properties of the composite that is synthesized at 1050°C are displayed in Table I along with the values for the end members Al_2O_3 and Al for comparison. Composites of Al_2O_3/Al have the advantage of complete thermodynamic compatibility and exhibit no solubility of one phase into the other resulting in strong interfacial bonding. Two remarkable features of the composite are related to the stability of the microstructure during long hours in service and strengthening by the ductile metallic phase. Grain growth is severely restricted and the microstructure coarsens only with an increase in temperature. It has been observed that tensile stresses in the ductile metallic phase could increase by 4–20 times the recognized flow stress during tensile testing. This occurs as a result of the high levels of mechanical constraint that exist in these microstructures.

The overall effective properties of the interpenetrating composites are of great importance in both their engineering applications and theoretical analysis. Theoretical analysis of these materials provides their overall behaviour from the known properties of individual constituents. Various estimation schemes, for example, non-interacting or dilute concentration method, self-consistent method, and Mori-Tanaka method may be used to calculate the effective properties (e.g., elastic moduli, thermal conductivity, etc) over the whole composition range. It is generally observed that interpenetrating phase morphology allows each component to maximize the contribution of its most desirable mechanical properties to the composite as a whole, thereby endowing the composite with a more attractive combination of properties than would be possible if one of the phases was isolated.

AL_2O_3/AL COMPOSITE IS READY FOR APPLICATIONS

The combination of alumina and aluminium is well known and has many applications. For instance, α-alumina has been used in the electronic industry for many years as a ceramic insulator, whereas aluminium is one of the best electrodes, having good electrical conductivity, second only to copper. Powders and fibre of alumina are also used to reinforce aluminium alloys, one of the most common lightweight materials for components in automobile engines and other transportation systems. In many of these cases, the formation of a strong alumina/aluminium interface is required. Interpenetrating composites containing ceramic alumina phase up to 70vol% could provide various advantages and the combination of properties offered by these composites is attractive for many potential applications.

A few composite shapes fabricated using silica precursors and a miniature component machined from a bar of this composite by the electro-discharge machining technique is displayed in Fig.2 (a & b). Near net-shape forming capability and an attractive range of properties including high temperature strength, fracture toughness and stiffness, lower co-efficient of thermal expansion, increased wear resistance, appreciable electrical and thermal conductivity and relative ease of machining are the principal merits of the reaction processed IPN Al_2O_3/Al composites. Widespread applications for the processing of wear resistant components are foreseeable, provided that a reduction of costs is achieved. Using cordierite, clay, fly ash or other silicates for preform fabrication may help reaching this objective. It is also possible to incorporate into the precursor composition a second phase to tailor some

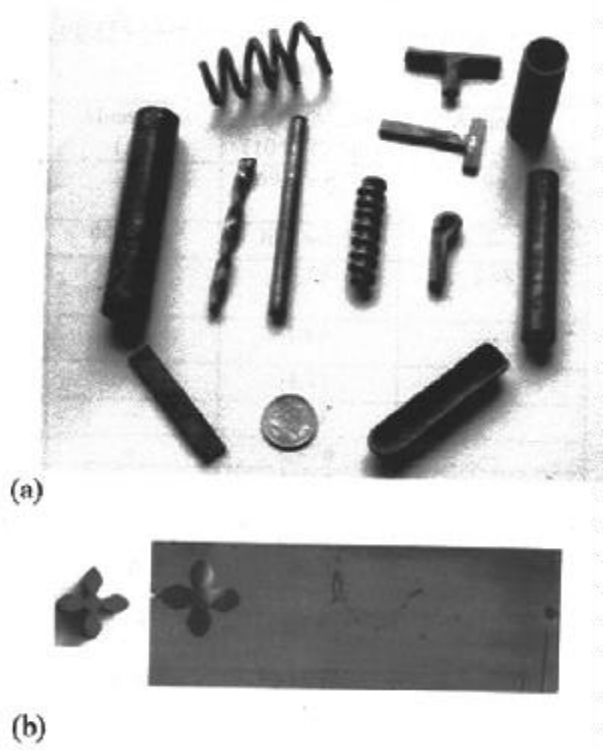

Fig.2. (a) Near-net shapes of interpenetrating Al_2O_3/Al composites fabricated using silica precursors,
(b) Miniature complex shape machined by electrodischarge machining (EDM) of interpenetrating Al_2O_3/Al composite bar. (L 50 mm × W 15 mm × t 5 mm)

characteristics of the final composite. The products/process is advantageous for the fabrications of automotive components, for example, brake-rotors and calipers ; cylinder bore liners, piston components, and turbo rotor assemblies. In the field of electronics, it may be used as heat sinks, and substrates. The interconnectivity of the ceramic phase imparts a few advantages in properties and shows promise as armour materials. Porous alumina structures

may be fabricated by etching out the Al-phase with dilute NaOH solution.

Table I. Experimentally Determined Property Values for Reaction Synthesized Al_2O_3/Al Interpenetrating Composities using Silica Precursors.

Property	Unit	Aluminium (Al)	Al_2O_3/Al IPC (1050°C/ 24h)	Alumina (Al_2O_3)
Phase composition	Al_2O_3	–	69.3 vol.%	≥ 99.5
	Al	99.5 min.	30.7 vol.%	–
Density	g.cm^{-3}	2.70	3.55	3.98
Shrinkage	% (Linear)	–	1.67	–
Avg. grain size	Al_2O_3, micron	–	4.27	–
	Al, micron	–	1.42	–
Contiguity	Measured Al_2O_3	–	0.476	–
	Measured Al	–	0.568	–
	Calculated Al_2O_3	–	0.425	–
	Calculated Al	–	0.575	–
Young's Modulus (Y)	GPa	66	206.3	400
Shear modulus (G)	GPa	23.5	80.8	164
Bulk modulus (K)	GPa	70.60	154.1	252
Poisson's ratio (ν)	–	0.34	0.277	0.234
Compressive strength	MPa		762.0	3000
Bend stength	MPa		326	380
Microhardness (Vickers)	V H N		482.9	
Coeff. thermal expansion (α)	x10^6/°C (100-600°C)	27.88	10.08	6.46
Electrical conductivity	Ω^{-1}cm^{-1} at RT	3.5×10^5	0.40×10^5	1×10^{-14}
Surface profile (Ra. μm)	EDM-cut	–	3.17	–
	Diamond-cut	–	0.30	–

These are, however, potential areas and actual use will be governed by high reliability, superior properties, component size, and shape complexities that must be achieved at competitive costs and are subject to considerable pressure from well-established materials.

CONCLUSIONS

The chemistry of corrosion of silica-containing ceramics by molten aluminium could be utilized for the synthesis of interpenetrating phase Al_2O_3/Al composites. These composites possess an attractive range of properties and are truly multifunctional materials. These novel materials are poised for a variety of applications in advanced technologies.

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PLANT BIOTECHNOLOGY : DEVELOPMENT AND ITS SIGNIFICANCE IN AGRICULTURE

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The concept of modern biotechnology developed after the science of genetics had progressed. The elucidation of structure of DNA, discovery of restriction endonuclease and ligase enzymes and other related discoveries led to the establishment of the array of new tools and techniques used in biotechnology. The practical implication of biotechnology in the society includes a number of life saving drugs, transgenic beneficial microorganisms, transgenic animals and transgenic plants with improved efficiency.

Biotechnology involves the use and manipulation of living organisms to get products useful for mankind. The concept of biotechnology is not new, in fact it is as old as the human civilization. The new biotechnology, however, has the clear distinction, from the older one, which was not at all related with the concept of gene and gene function.

Tools and Techniques Used in Biotechnology

The tools and techniques strengthening the present day biotechnology include the following :

1. Gene isolation : During 1970 to 1980, a significant progress was made in the techniques for isolation of a variety of genes including those for ribosomal RNA, specific protein products, phenotypic traits with unknown gene product and those for regulatory functions, e.g., promoter genes using reverse transcriptase enzyme and labeled probes.

2. Gene synthesis : A breakthrough came in 1970 when a gene of 77 bp for alanyl tRNA in yeast and the first functional gene of 207 bp long coding tyrosine suppressor tRNA were synthesized by H. G. Khorana in 1979[1].

3. Gene cloning : After the discovery of restriction and ligase enzymes, gene cloning became possible by inserting the genes of interest into the suitable cloning vector (which is itself a self-replicating DNA molecule, e.g. plasmids, phagemids, cosmids, artificial chromosomes, etc.) can get number of identical copies of the genes inserted, for example, cloning and sequence analysis of rol C gene affecting ginsenoside contact in hairy roots of *Panax ginsing*[2].

4. Gene sequencing : In the mid 1970's the techniqes of gene synthesis were developed. Sanger[3] was the first to report a complete DNA sequence of ϕ X 174, comprising 5375 nucleotides that code for 10 proteins. Two methods of gene sequencing are generally followed : first is Maxam and Gibert's chemical degradation method and the second is Sanger's dideoxy nucleotide synthesis method. Now a

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days, automatic gene sequencer is available in the market.

5. Transfer of genes : The uptake of foreign DNA or transgenes by plant cells is called transformation. A number of techniques have been used to introduce transgenes into the plant cells such as *Agrobacterium* mediated gene transfer and direct gene transfer, i.e., direct uptake by using polyethylene glycol (PEG), electroporation, particle gun method, microinjection, macroinjection, lipofection, fibre mediated DNA delivery, laser induced DNA delivery, pollen tranformation, DNA delivery via growing pollen tubes and direct DNA uptake by mature zygotic embryos, etc.

6. Discovery of PCR : Kary Mullis (1985) invented a technique called PCR (polymerase chain reaction, also called people choice reaction) that made it possible to find and amplify specific segment of DNA from complex mixture.

7. Reverse transcriptase : This is an RNA-dependent DNA polymerase discovered by Temin and Baltimore[4] in 1970 which is generally obtained from avian mycloblastosis virus (AMV). This enzyme performs similar reactions as DNA polymerase.

8. Molecular markers : A molecule which exhibits an easy detectable polymorphism is used for preparing molecular map/genomic map. Molecular markers can be classified as hybridization based (e.g., RFLP : restriction fragment length polymorphism), PCR based (e.g., RAPD : random amplified polymorphic DNAs ; AFLP : amplified fragment length polymorphism) and micro-and mini-satellites. The molecular markers are used in plant breeding for indirect selection of desired plants at early stage by using gene tagging, genomics, tagging of disease resistance gene[4] and microsatellites[5]. RNAi technology has been used to generate rice with resistance to phytopathogenic fungus *Magnapirtha oryzae*[6] and post transcriptional gene silencing in plants.[8]

9. Microchips : Microchips are 2-3 cm wide slides either of silicon or glass bearing thousands of immobilized snippets of DNA that serve as probes for detecting DNA fragments with a complementary nucleotide sequence[9]. Microchips can be used for disease diagnosis, identification of HIV, cancer, formation of drug, functional genome analysis and comparative gene expression analysis.[10]

The very recent concept of genetic engineering includes the development in genomics (word *genomics* was coined by T. Roderik in 1986) which includes mapping, sequencing and functional analysis of the genome of any organism which is classified as structural genomics[12] and functional genomics[13]. In 1995, the first complete organized genome sequence of *Hemophilus influenzae* was announced and the first complete eukaryotic sequence of yeast became known in 1996 followed by *Arabidopsis thaliana* and the second plant genome project on rice continues since 1998, which is likely to be completed). Proteomics refers to as the functional genomics at protein level. It is of two types : the first one is the expression proteomics and the second is cell map proteomics which includes two techniques, i.e., 2D PAGE and mass spectrometry[14]. These techniques creating the ray of hopes for the future of the billions population of the world. The all above

developments in genetic engineering have opened up new opportunities to manipulate genes across the genetic barriers for obtaining useful commercial products. Therefore, transgenic means any organism having foreign gene across the crossing barries.

Important Transgenic Plants

A number of transgenic plants developed so far through plant genetic engineering for different agronomic and qualitative traits are as below :

1. Herbicide tolerant transgenic plants have been engineered by using mutants EPSP (5-enolpyruvyl shikimate-3-phosphate) synthetase enzyme, e.g., soybean, canola, cotton, tobacco, etc.

2. Transgenics for insect resistance have been developed by introducing a gene from *Bacillus thuringiensis* coding a toxic protein (delta endotoxin) which inhibits insect growth, for example, Bt cotton, Bt maize, Bt tobacco, etc.[15]

3. Transgenics for male sterility (*Barnase* and *Barstar* in *Brassica* spp. for hybrid seed production).

4. Stress resistance transgenics, e.g., chilling resistance in tobacco, a gene for glycerol-1-phosphate transferase was introduced from *Arabidopsis*.

5. Transgenics for disease resistance such as fungal diseases[7], bacterial disease, viral diseases, etc.

6. Transgenics for food processing, namely, Bruise resistance tomato (expresses antisense RNA against polygalacturonase which attacks pectin), delayed ripening in tomato by antisense RNA (ACC synthase), e.g., Flavr Savr, Endless Summer in tomato.

7. Nutritional quality transgenics such as golden rice developed by Ingo Potrykus of Switzerland, which has high amount of beta carotene (precursor of vitamin A) and iron content[15] and golden potato, etc.

Transgenic crops occupy 52.6 million hectares area in the world. Out of the total area of the world under transgenic crops there are three countries, namely, USA, Argentina and Canada which cover more than 90 per cent. The major crops occupying about more than 80 per cent area are herbicide-tolerant soybean (33.3 m ha), *Bt* corn (5.9 m ha), herbicide-tolerant canola (5.7 m ha), herbicide-tolerant cotton (2.5 m ha) (www.isaaa.org). The three varieties, namely, Mech 12, Mech 162 and Mech 184 of *Bt* cotton have been released in India for commercial cultivation in the recent past.

These developments and their practical impact are, however, not entirely free from criticism and problems. The discovery of control of plant gene expression dubbed as terminator technology (because it terminates the farmers' right to reuse their seeds) by a Canda based non-government organization (NGO), namely, Rural Advancement Foundation International (RAFI) which refers to as the ability of genetically modified plant to render its seeds sterile (non-viable), for example, cotton and tobacco. This technology developed by Monsanto was described as gene protection technology and patented by Delta and Pine Land and USDA in March, 1998 which was described as technology protection system. Another technologies viz., verminator (developed

by Zeneca) refers to inhibit plant growth rather than killing the seeds and traitor technology (developed by Novartis) refers to the use of an external chemical inducer to turn 'on' or 'off' a plant's genetic traits put the question mark on the usefulness of biotechnology to the society and existence of biodiversity[18]. The achievements in the field of agriculture, medicine and industry have proved the usefulness of the biotechnology and it is now predicted that the future would be entirely dependent on the biotechnology.

Keeping in view all the usefulness of the biotechnological revolutions and the related drawbacks, it is important to monitor so that no hazardous impact comes in the society while bringing the products of biotechnology into practical use.

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DO YOU KNOW?

Q7. How many km. does an average person walk in a lifetime?

Q8. What is the name of the first test tube baby?

SHORT COMMUNICATION

THE BITTER TRUTH

D. Balasubramanian*

It might sound unbelievable, but it is true that of all the tastes it is the bitter taste that appears to be the most common. Rephrasing this a little better, among the various taste stimuli, substances that elicit a bitter taste seem to be the most abundant. This is not necessarily to say that the bitter taste is the most preferred one. As everyone knows it is perhaps the least preferred ; the one most preferred obviously is the sweet taste but then, as with most other things in life, what happens to be useful is almost always the least attractive and the most attractive may even be harmful. A sweet tooth is fine but a tooth that is in constant contact with sweet substances tends to rot soon. This is largely because bacteria too like sweet things like sugar and start growing on the dental surface where the sugar may still be stuck. Infection by these bacteria or even the simple release of acid and other corrosive substances by them leads to tooth decay. On the other hand, most medicines that we take are bitter in taste. Quinine, the medication against malaria, is one of the bitterest-tasting substances known. The colonial Englishman in the East Indies who realized this devised an attractive way of taking the drug ; he mixed quinine with water, soda and some gin and thus was dorn the cocktail "gin and tonic" (G&T).

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Even some stimulants and addictive drugs are bitter in taste. The active principle in coffee is the alkaloid caffeine which is the stimulant that perks you up. But caffeine is very bitter tasting and that is just as well, because the bitter taste serves as a built-in deterrent against excessive intake. It is a different matter that we make a cocktail even out of coffee by mixing it with Irish whisky and cream, or with plain hot water, milk and sugar. The stimulant in tea is another alkaloid called theophylline, which also has a bitter taste. One of the most poisonous substances known is brucine, 1mg of which is sufficient to kill a fat rat weighing 1kg. It is also one of the bitterest substances known with a threshold of one in 2 20 000. Brucine and its relative, strychnine, have been used not only as rat poisons but even as stimulants of the central nervous system (CNS). Uses of these are fraught with the gravest of dangers because while in minute amounts they stimulate the CNS extremely, a slight increase in the dose can lead to such severe brain damage that the addict becomes for all practical purposes a vegetable. The vicarious pleasures of such drug taking are, unfortunately, only too well known. Even a great intellectual like Aldous Huxley seems to have revelled in the use of such addictive drugs.

Bitter substances have posed a challenge to biochemists and physiologists. What is the basis

of the bitter taste ? The answer is yet to come despite of research in the area. Some consensus appears to be slowly emerging. Early work in the area was done by Steven Price who also noted that the chemical structures of the bitterest substances are extremely diverse. There appears no common structural patterm, motif or shape that could be associated with the bitterness principle. On the one hand are complex alkaloids like brucine and on the other are simple molecules like sucrose octa acetate. The later is praticularly interesting because surcrose is the cane sugar which we use everyday in our food and is, of course, sweet in taste. Its sweetness is related in some way to the several hydroxly groups that the molecule carries (glucose and the fruit sugar, fructose are similar polyhydroxy compounds which also taste sweet ; even glycerol with only three hydroxly groups tastes sweet). But when its eight hydroxyl groups are esterified by reaction with vinegar, we obtain sucrose octa acetate which is bitter in taste !

At present, the only general principle that is accepted by many workers in the area is that bitter substances are generally insoluble in water. In other words, they are fat soluble or liphophilic. The usual feature about any sensory perception such as taste or smell is that there exists a "receptor" molecule, usually a protein, on the surface of the cell. This receptor protein binds to the signal substance of taste or smell. Upon such binding, the protein changes its shape or electrical properties and transmits a signal. The receptor for each class or family of sensory molecules is thought to be a unique one. Thus, one talks of an "opioid" receptor that "receives" or binds to opium and other related mind-numbing drugs. This idea suggests a common mechanism or mode of action, normally based on a shape-dependent fit of the molecule to the receptor, like a key and a lock or a glove and the hand.

The fact that the chemical structures of bitter compounds are very diverse has argued against the possibility of a protein acting as a receptor or as a jigsaw surface on which they can bind and elicit their response. Indeed, it is diffcult to consider a shape-specific receptor surface because even molcules with two closely related shapes differ in their tastes. The amnio acid aspartic acid is slightly sweet, whereas its cousin amino acid leucine is bitter. Then, again, there is this classification of what may be called the "taster" or "non-taster" substances. The substance called thiourea tastes bitter to some people but not so to others. How does one account for this ? A group of Japanese workers led by Dr. kenzo Kurihara of the Pharmaceutical Sciences faculty of the Hokkaido University, Sapporo, Japan and Tadashi Nomura and Yoshihisa Katsuragi of the Kao Corporation in Tokyo, have been doing sustained work in this area and have given us some leads in this matter.

First of all, they underscore the point that all attempts to isolate the receptor protein for bitter substances have not succeeded. Next they showed that certain types of mouse nerve cells (called neuroblastoma) respond to bitter substances in the same way that human taste cells do. Now, one expects to find taste receptor proteins in the taste (gustatory) cells of the mouth but not in neuroblastoma cells of mice. But what these two cell types will have in common are the lipid molecules that go to make up the cell members. so, could it be that membrane lipids act as "receptors" for bitter substances ? After all, these latter compounds share one property, namely that they are fat soluble or lipophilic. Recall that sweet-tasting sucrose is water soluble but its

octa acetate, which tastes bitter, is not water soluble but dissolves in oils, fats and in lipid membranes.

Accordingly, Kurihara and co-workers decided to make artificial memberances using pure lipids alone and decided to investigate their properties upon the addition of bitter sunstances to them. Lipid balloons called limposomes from soyabean phospholipids were prepared as mock cells and their electrical properties measured as caffeine, brucine, quinine and other bitters were added. Surprisingly enough, each one of these altered the electrical potential values in a definite fashion. The membrane potential was increased by as much as 5–8 millivolts, That is, the memberane was depolarized. The more bitter a substance is, the more at depolarized the liposome electrical potential value. Even more interestingly, they found a correlation between this ability of the bitter molecules and their taste thresholds in humans.

It thus appears that bitter substances produce their effects or responses by binding to the lipid regions of cell membranes. Now, lipids come in various types–abbreviated as PC, PA, cholesterol, SM and so on, and cells differ in their lipd compositions. So then, should the membrane depolarization effect of bitters not depend on the lipid composition of the cell membrances ? Kurihara and co-workers showed that it does. This difference in lipod composition, they conclude, is in fact the basis for the difference in "taster" and "non-taster" property of the substances.

What happens after the membrane is depolarized by the bitter compounds ? This electrical signal is assumed to travel to the synaptic area of the taste cells, or to their nerve endings where a chemical transmitter molecule is released. It is likely that messenger molecules called cyclic nucleotides modulate the process in definitie ways. Further research will establish these mechanistic steps.

The fact that bitter substances bind to the lipid surface of membranes has interesting consequences. It offers a way of "masking" or neutralizing the bitter taste. Perhaps, all one might need to do is to use other lipophilic substances which can go and attach themselves to the membrane more tightly. That would prevent the bitter compound from binding to the membrane site and sending off the depolarization signal. Such a "musical chair" strategy has been attempted by Katsuragi and Kurihara. They showed that the lipophilic mixture made of the lipid PA and the protein beta-lactoglobulin (LG) can completely suppress taste responses in humans to all bitter substances. Happily enough, it is specific to bitter stimuli and does not affect the responses to other taste stimuli such as salty or sweet. It also appears to mask the taste of a variety of bitter substances, suggesting that it binds to multiple sites in the membrances. The lipid PA is readily obtained from soyabean and the protein LG is found in milk. Hence, the mixture PA : LG is perfectly safe and natural, actually it may be called tofu milk. Its use as a flavour-maskig agent for bitter substances will not be long in coming, and one expects it naturally from the company that promoted this research programme. Incidentally, it was another Japanese company that first introduced the flavour-enhancing substance monosodium glutamate in the form of ajinomoto powder. Perhaps it will be the Kao Corporation that will market PA-LG powder as a bitter mask.

LIFE SKETCHES OF GENERAL PRESIDENT AND SECTIONAL PRESIDENTS 93rd INDIAN SCIENCE CONGRESS, HYDERABAD 2005-2006

DR. I.V. SUBBA RAO
General President

Dr. I. V. Subba Rao, an eminent Agricultural Scientist, was a Post Graduate from Andhra University and Ph.D from the Indian Agricultural Research Institute, New Delhi.

A Soil Scientist by profession, he has wide, varied and rich experience in Agricultural Education, Research, Extension, Research Management and Administration of over 50 years of distinguished service to the farming community and rural areas. He started his career as an Agricultural Demonstrator, the lowest post in the Agriculture Department, and rose to the highest Academic position, of Vice-Chancellor of Acharaya N.G Ranga Agricultural University, Rajendranagar, Hyderabad for two terms. Dr. Rao has handled state and national assignments with skill, served with distinction and made significant contributions in Agriculture and allied fields.

He has several outstanding scientific contributions in Soil Chemistry, Soil Fertility, Micro-nutrients, Agronomic Management of Crops, Cyclones and Disaster and Epidemics management and contributed substantially to prevent poverty and hunger.

His research contributions in the fields of phosphorus, potassium in soils and their management in crops, improved nitrogen use efficiency, classical research on zinc and other micro-nutrients in soils and crops, rice fallow pulses have been well recognized. These have greatly helped to significantly improve crop yields, production of food and non-food crops, economic empowerment of farmers and employment in the rural areas.

His research work on phosphorus in relation to crop production in rain fed black soils and the negative interaction between phosphorus and molybdenum in alkaline soils has global significance. Dr. Rao is one of the earliest scientists to initiate research work on micronutrients in India, way back in 1950's. His efforts as Associate Director of Research and Director of Research of ANGRAU in the field of hybrid rice research have led to the release of India's first rice hybrids (APHR 1 and APHR 2) by the University, and next to China in the world.

He has several innovations and reforms to his credit in the fields of Agricultural Education, Research and Extension including four Model Reports given to the ICAR/The World Bank.

Dr. I. V Subba Rao was the President of Indian Agricultural Universities Association,

Chairman, ICAR Committee of Vice-Chancellors on University Governance, Chairman, Committee on Personal/Financial Policies of the Accreditation Board of ICAR, Vice-President of Indian Society of Soil Science, Chairman, Research Advisory Committees of Central Research Institute for Dry land Agricultue, Hyderabad, Central Tobacco Research Institute, Rajahmundry, National Research Centre on Palm, Pedavegi, Central Arid Zone Research Institute, Jodhpur, and Chairman, Board of Management, ANGRAU. He was Chairman or Member of several National and State Committees and Co-Chairman, Session VIII of Commission IV of the 12th International Congress of Soil Science, 1982.

Currently, Dr. Subba Rao is serving as Director General, Jawaharlal Nehru Institute of Advanced Studies, Hyderabad ; President, North South Foundation, and Chairman, Research Advisory Comittee, National Research Centre for Sorghum. He was also Member, High Power Committee on EAMCET, APSCHE, Member, Committee to review the existing system of ARS/NET Examination, Agricultural Scientists Recruitment Board, GOI, Member, Expert Committee for standardization of curriculum and UG/PG Course, APSCHE, Govt. of Andhra Pradesh.

His contribution in Agricultural Education, Research and Extension in serveral capacities has enabled ANGRAU to win two National Awards namely, the ICAR Best Institution Award for the year 1999 and Best Performance Award in 2000 during his tenure as Vice-Chancellor.

His scientific achievements and services to the farmers have been recognized by several organizations, institutions and the National and State Governments. In recognition of his distinguished service, Dr. Rao was awarded the prestigious "Padma Sree" by the President of India in 2002 and Dr. Norman E. Borlaug Award in 2004. He was also receipient of many awards, which include the Eminent Scientists Award of A.P. Academy of Sciences, India 2000 Millennium Award by IAEWP affiliated to UNICEF, Sir C.V. Raman Council of Professional Expertise Award for Science and Technology, Life Time Achievement Award by Cotton Research and Development Association, Dr. Nannapeneni Narashimha Rao Memorial Award, "Man of the Year", 1985-Best Service Award of Rotary International and "Rythu Bandhava" and "Karshaka Ratna" titles. He is a Fellow of the A.P. Academy of Sciences, Indian Society of Soil Science and Indian Society of Coastal Agricultural Research.

DR. D. SARKAR
President
Section of Agriculture and Forestry Sciences

Dr. Dipak Sarkar (Born on 15th January, 1952) did his B. Sc. (Ag) Hons. from Kalyani

University and M. Sc. & Ph. D. from the Indian Agricultural Research Institute (IARI), New Delhi in Soil Science and Agricultural Chemistry. He started his career as Scientist (SI) and rose to the position of Principal Scientist and Head, National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Kolkata in 1996. Dr. Dipak Sarkar has significantly contributed in the field of Agricultural Sciences. He has worked in the areas of Natural Resources Appraisal and Monitoring, Application of Remote Sensing Database for Soil Survey and Mapping, Land Evaluation towards Land Use Planning at regional, district and watershed level, Soil Based Data Mangement System through Geographic Information System, etc. His research interest covers several aspects of pedology and soil chemistry with indepth studies on Status, Causes and Impact of Arsenic Contamination in Ground Water in parts of West Bengal *vis-a-vis* Management of Agricultural Systems. He has published more than 75 Research Articles in reputed referred Journals, 35 Technical Bulletins, 2 Books and 8 Book Chapters. He has handled several Research Projects and has successfully guided some Research Students for the award of Ph. D. Degree. Dr Sarkar has won several awards and recognitions. In recognition of his research contribution, he was awarded Fellow of Institute of Chemist, India, Foundation Fellow of West Bengal Academy of Science & Technology, Kolkata, Fellow of Indian Society of Soil Science, New Delhi and Fellow of National Environmental Science Academy, New Delhi. ; He was President, Indian Society of Remote Sensing, Kolkata Chapter, Vice President, Indian Society of Soil Survey and Land Use Planning, Nagpur, Recorder, Agriculture and Forestry Sciences Section of the 90th and 91st Session of the Indian Science Congress, Chairman, International Conference on "Environment and Development" in the Session "Control of Pollution (Soil and Plants)", President, Indian Society of Soil Science, Kolkata Chapter. He is member Editorial Board, Indian Society of Soil Science, New Delhi, Research Adviory Committee, Institute of Wetland Management and Ecological Design, Kolkata, Council Member, Indian Science Congress Association, Kolkata and also Institution of Chemist, India and nominated Member of the State Land Use Board, Govt. of Tripura. He has been invited to deliver lead lectures at several scientific fora all around the country.

PROF. N. AGRAWAL

President

Section of Animal, Veterinary and Fishery Sciences

Prof. Nirupama Agrawal was born on 17 Jan. 1954 at Hardoi (Uttar Pradesh). She has throughout a first class career. She did her B. Sc. (with Bursary scholarship), M. Sc. Ph. D.

(JRF-CSIR) and D. Sc. from the University of Lucknow and was awarded Prof. K. N. Bahl Gold Medal (1974) for securing highest marks in M. Sc. She had fellowships of the Helminthological Society of India and Zoological Society of India and was honoured with Bhalerao Gold Medal (2000) of the Society. She has also worked as a research associate with Prof. Mary Bevereley Burton, University of Guelph, Canada (1994-1995). She started her career as a Lecturer (1976) and then became Reader (1987) and Professor (1997) in the Department of Zoology, University of Lucknow. Presently Prof. Agrawal is Head, Department of Zoology of the University of Lucknow. Prof. Agrawal is known for her contributions in the field of Fish Parasitology. Her research work has been cited in a number of books. Prof. Agrawal has about 31 years of research experience, guided 11 Ph. D. students and published about 117 research papers in India and foreign journals of repute, attended several National and Interntional Symposia held at Czechoslovakia (1988), France (1993) Czech (1997), Australia (2001), South Africa (2003) and China (2005). She was elected as Recorder of the Section of Zoology, Entomology and Fisheries 2000-2002, then member of Executive Council of ISCA 2002-2003, and Member of Executive Committee of ISCA 2004-2005 and 2005-2006 and at present she is President of the Section of Animal, Veterinary and Fishery Sciences 2005-2006. She is member of many professional organizations, academic bodies and societies like, ISCA, Zoological Society of India, and Helminthological Society of India, Indian Society of Biosciences.

DR. R. K. PATHAK
President
Section of Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)

R. K. Pathak (born 1953) did his B. Sc. (Hons.) and M. Sc. (Hons.) in Anthropology from Panjab University, Chandigarh. He was also awarded National Scholarship for standing first in B. Sc. (Hons.), and Dewan Bahadur Wali Ram Taneja Gold Medal for standing first in M. Sc. (Hons.). He earned his Doctorate of Philosophy in Physical Anthropology from the same University while holding a UGC Fellowship. Dr. Pathak began his career as a Pool Officer of Council of Scientific and Industrial Research at the Department of Anthropology, Panjab University. Thereafter, he joined the Department of Anthropology, North-Eastern Hill University, Shillong where he served as Lecturer and Reader. In 1998 Dr. Pathak joined the Department of Anthropology, Panjab University, Chandigarh, as Professor. Prof. R. K. Pathak was Head of Department of Anthropology at NEHU from 1994-1997, and at P. U. from 2002-2005. Presently, he is the Co-ordinator of UGC Special Assistance Programme

in Anthropology at Panjab University. During more than twenty-five years of his anthropological research and teaching career Prof. Pathak has acquired experience in the fields of human growth, nutrition, development and physique ; human and primate anatomy and evolution ; sports anthropology ; dental anthropology ; ecological anthropology ; bio-social anthropology (health and disease). His scientfic research publications find place in national and international journals, such as American Journal of Physical Anthropology, Annals of Human Biology, Journal of Human Evolution, International Journal of Anthropology, Zeitschrift Morphologic und Anthropologie, Journal of Anthropological Society of Nippon, South Asian Anthropologist, Indian Anthropologist, etc. He has also co-authored two books. He is and had been a member of many Academic and Professional Bodies. Prof. Pathak has actively participated in many National and International Conferences in India and abroad.

PROF. C. S. MATHELA

President

Section of Chemical Sciences

Prof. C. S. Mathela, born on 12th May, 1950 at Champawat (Uttaranchal), obtained his Master's degree specializing in Organic Chemistry from Agra University in 1969 and joined teaching profession as Lecturer in August, 1969. He received Ph. D. degree from Kumaun University in 1976 for his research work on Chemistry of Aromatic and Medicinal Plants. He has been recipient of Visiting Associateship (CSIR) and National Associateship (UGC). He was appointed Reader in 1984 and Professor of Chemistry in 1995 in Kumaun University, Nainital where he has been holding the post of Head, Chemistry Department for the last 15 years. He has been Dean, Science Faculty of the Kumaun University during 1998-2001 and Campus Dean Science during 2002-2005. He was awarded the Dr. D. R. Dhingra Medal for his work in Essential oil Research in the year 1985 and 1989 and Acharya Narendra Dev Medal for Meritorous Services in 2003. He has been expert member of Various committees viz, NAAC, UGC, DOEn and Board of Studies in various universities. Prof. Mathela's research interests include Natural Products Chemistry and has published over 100 research papers in National and International Journals on different aspects of Himalayan aromatic and Medicinal Plants. Thirty one students have been awarded Ph. D. degree under his guidance. He has held Visiting Research Assignments in California State Polytechnic University Pomona in 1985, 1991 and 1996 and was awarded Fulbright Fellowship in 1986-87 and joined University of California, Davis and worked with Prof. Albert T. Bottini. He has participated and Chaired several National and International Conferences, Seminar / Symposia and organized

National Symposia on Natural Products Chemistry and Utilization of Himalayan Natural Resources. Prof. Mathela has completed several research projects on Himalayan Aromatic and Medicinal Plants and established CG-MS Central Facility as Advanced Centre in the Department of Chemistry with grants from the Department of Science and Technology, New Delhi.

DR. R. KUMAR

President

Section of Earth System Sciences

Prof. Ravindra Kumar was born at Jaunpur, Uttar Pradesh. He obtained B. Sc. (Hons.) in 1962 and M. Sc. (Geology) in 1964 from the Banaras Hindu University, Varanasi. He later joined as Research Student at the Centre of Advanced Study (CAS) in Geology, Panjab University, Chandigarh and obtained Ph. D. from the Panjab University in 1969. Prof. Kumar joined the faculty of the CAS in Geology, P. U. as Lecturer in January 1970. He was invited as UNESCO Fellow from September 1974 to June 1975 to the Moscow Geological Prospecting Institute. Prof. Kumar served as Colombo Plan Expert, Lecturer in Geology, Tribhuvan University, Nepal, from August 1976 to September 1979 under the Indian Cooperation Mission, Ministry of External Affairs (Government of India). Prof. Kumar was promoted as Reader in March 1984 and as Professor in April 1996 at the Panjab University. Prof. Kumar also served as Associate Professor, King Abdullajij University, Saudi Arabia for one academic year (1989-90). Prof. Kumar currently holds the position of Professor & Co-ordinator SAP-CAS, Centre of Advanced Study in Geology, Panjab University Chandigarh.

The research interests of Professor Kumar include Structural Geology and Tectonics of the Himalaya, Mining Geology and Mineral Economics ; Remote Sensing and GIS, and Active Faulting and Natural Disaster Management. He has contributed to over 52 research papers in national and international journals on various aspects of the geology and tectonics of the Himalaya during over four decades of his research career. He has participated in several national and international seminars and symposia. Prof. Kumar is currently engaged on the study of Neotectonic structures and tectonic geomorphology of the Himalaya. He is currently member of the National Working Group of International Geological. Correlation Program No. 476 on "Tectonic Climate Linkage in Asia". Professor Ravindra Kumar is the author of "Fundamentals of Historical Geology and Stratigraphy of India." Professor Kumar is Life Fellow of Geological Society of India, Bangalore and Indian Geologists' Association, Chandigarh.

AR. V. K. MATHUR

President

Section of Engineering Sciences

Shri V. K. Mathur, Former Director, Central Building Research Institute (CBRI), Roorkee graduated in Architecture from University of Roorkee (Now IIT Roorkee) in the year 1967 and did his post graduation in Urban and Rural Planning also from UOR. He is a topper and gold medalist in both graduation as well as post graduation. He joined CBRI in the year 1967 and worked in different capacities. He was appointed to the coveted post of Director, CBRI in January 2001. Shri Mathur has made significant contribution to the R & D specially in the area of shelter planning and coordinated various building projects of national and international importance. The R & D work conducted and coordinated by him in different disciplines of building science and technology has been recognized by many national and international forums. Shri Mathur has published more than 100 research papers, technical reports and articles. He has made significant contribution to the Revision of National Building Code (NBC) as a member of the Apex body. Under his guidence CBRI has contributed to a large number of Committees constituted for revision of the NBC. Shri V. K. Mathur is a Fellow Member of Indian Institute of Architects, Institute of Town Planners (India), Institution of Engineers besides Member of Council of Architecture, Member of CIB working group on Architectural Management from India. He is Chairman / Member of Governing Councils of BMTPC, CDC, NCB, CRRI and many other organizations and professional bodies. He served as the President of Indian Building Congress (IBC) for the year 2004-2005. Shri Mathur has visited a large number of countries across the globe on important missions and has chaired a number of technical sessions / committees during his visits to overseas countries. He was invited to chair technical sessions at International meet held in Japan, The Netherlands, U. K. and U. S. A.

PROF. M. CHATTERJEE

President

Section of Environmental Sciences

Born in December 1946, Dr. Malay Chatterjee Ph. D, D. Sc. is working as a professor in the Department of Pharmaceutical Technology, Jadavpur University from June 1976 to present. He was a post-doctoral research associate at the University of Nebraska, USA for a couple of years. He was also a visiting scientist to USSR during 1979 & 1980. He is working in the areas

of molecular mechanism of environmental carcinogenesis. He is leading an active school of research in the specific areas of chemical carcinogenesis. Prof. Chatterjee has 137 international publications in peer reviewed high impact journals. 36 students have been awarded PhD under his guidance. He has successfully completed many CSIR, DST and ICMR projects and several projects of different sponsoring agencies are being carried out at present. He has chaired many national and international conferences in India and abroad. He is a member of the editorial board and in the reviewer panel of many well-known international journals. He is also a vice-president of West Bengal Voluntary Health Care Association in an honorary basis. Prof. Chatterjee made tangible contributions in the field of chemical carcinogenesis and wrote a few books, review articles, guest articles and editorial articles in many foreign journals.

DR. S. B. NIMSE
President
Section of Information and Communication Science & Technology (including computer sciences)

Sarjerao Bhaurao Nimse, born on 14th November 1950, completed his primary school and college education in Ahmednagar city. He passed M. Sc. (Mathematics) from and Pune University. M. Phil in Mathematics from the Institute of Advanced Studies, Meerut University. He received U. P. Governor's award for distinguished achievement in M. Phil examination. Dr. S. B. Nimse obtained his Ph. D. degree from the Meerut University in the year 1982, for his thesis on General Topology. In his Ph.D. thesis, he had introduced many original concepts about separation and covering axioms in general toplogy. These concepts were further developed by many researchers, signifying the importance of these ideas. Dr. S. B. Nimse has served as a lecturer in Mathematics for 30 years teaching mainly at P. G. level, Guiding eight students for Ph.D. of Pune University. He has written ten books on mathematics and published eight papers in national and international journals. Dr. S. B. Nimse has actively participated in working of various bodies of Pune University. Presently, he is a Dean of Science Faculty, University of Pune. Earlier, he has served Pune University in various capacities such as chairman of the Board of Studies etc. He is also working on academic bodies of other Universities. Dr. S. B. Nimse is a pioneer of management education in Ahmednagar city. He has served as a founder director of M.B.A. Programme of IBMRD since 1985 to 1990 and Director of Master programme in Computer Management (M.C.M) from 1991 to 1998. Presently, he is a Principal of the New Arts, Commerce & Science College Ahmednagar, which is a premier affiliant college of Pune University. Dr. S. B. Nimse is a life member of Indian Mathematical Society, ISCA, Computer Society of India, Mathematical

Association of India. Presently his group is working on Fuzzy Mathematics and its use in Information and Communication Technology (ICT). He and his research students are in active contact with the soft computing group from the Berkeley University, California, where fuzzy began. His present interest includes Theoretical Computer Science (TCS), Complexity Theory, NP-Completeness problem, Neural-networking, Optimization techniques and other related areas. He had visited various universities in U. S. A. during his visits in 1996 and in 2004.

PROF. R. K. PANDEY

President

Section of Materials Science

Prof. Pandey was born on June 24, 1953. He received the Masters and Doctoral Degree from Ravishankar University, Raipur. He is presently working as Professor of Physics at the Department of Physics, Barkatullah University (Bhopal University), Bhopal. Prof. Pandey has been holding several position in the administration of the University including Director, Institute of Physics and Electronics, Director University Computer Center, Director Research and Development, Dean-Faculty of Science, Member of the Board of Governors at University Institute of Technology, Bhopal etc. He is also a member of the Board of Governors of the NIT, Jamshedpur. Prof. Pandey has developed and headed several teaching departments and program at Bhopal University. Prof. Pandey has also been the Principal Investigator in over 15 research projects sponsored by Government Funding Agencies. Prof. Pandey has been a visiting scientist at the Department of Applied Chemical Physics, Polytechnic of Milan and the Department of Applied Chemistry at Waseda University, Japan. He has also conducted a Training workshop at the University of Malaya, Kualalumpur, Malayasia. He was also invited as JSPS Fellow to Japan. Prof. Pandey is internationally known for his research on electrochemical techniques for semiconductors, mutltilayers and self assembled nano-structures. He has made significant contribution to the development of novel electrodeposition strategies such as selective electrodeposition for growing high purity compound semiconductor films from low purity precursors, nonaqueous electrodeposition technique for binary and ternary semiconductor films, in situ characterization of electrodeposited semiconductors etc. Another significant research work of Prof. Pandey has been in the development of electrochemical strategies for growth of self organized quantum dots of II-VI semiconductors. His other research interests include development of IR detectors and thermoelectric coolers. He has co-authored the

first monograph in the field which was published by Marcel and Dekker, U. S. A. Prof. Pandey has also published over 60-research papers and review article in international journals, presented more than 50 papers in national and international conferences and supervised 15 students for their doctoral degrees.

PROF. B. ISWAR

President

Section of Mathematical Sciences

(including Statistics)

Professor Bhola Ishwar was born on 10th Jan 1945 in District Begusarai, Bihar. He did his Master degree in Mathematics in the year 1968 and Ph.D. from Bihar University, Muzaffarpur in 1975. He joined the University Department of Mathematics in the year 1971. He obtained D.Sc. degree in Mathematics from Ranchi University in 1990. He superannauted from Head of the University Department of Mathematics, and Dean Faculty of Science, B.R. Ambedkar Bihar University, Muzaffarpur in January 2005. Currently, he is Principal Investigator, DST project in the University Department of Mathematics, B.R. Ambedkar Bihar University, Mazaffarpur, for the period February 2004 February 2007. Professor Ishwar has published more than fifty research papers. His major research area has been Space Dynamics and Celestial Mechanics. Professor Ishwar has guided sixteen Ph.D. and one D.Sc. students and he has been Principal Investigator of three Major Research Projects. He is life-member, Indian Science Congress Association, Calcutta; National Academy of Sciences India, Allahabad; Astronomical Society of India (ASI) Hyderabad; I.M.S., Merrut; B.H.U.M.S., Varanasi and I.A.G.R.G. He is a member of Executive Council of Calcutta Mathematical Society from 2001 to 2006. He was member of programme committee of Satellite Dynamics in COSPAR during 2000-2004. Professor Ishwar has been Associate-Member of COSPAR Scientific Assembly and Senior Associate of IUCAA, Pune. He served as a referee in one International Journal–Celestial Mechanics and Dynamics Astronomy, Kluwer Academic Publisher, The Netherland during 1989-1990 and two National Journals–Indian National Science Academy (INSA), New Delhi and Bulletin of Astronomical Journal, Hyderabad. Prof. Ishwar has been regularly invited in many conferences/seminars/ workshops both National and International of Space Dynamics. He has been Visiting Professor in University of Texas, Austin, USA, 1986-1987; University of Zaragoza, Zaragoza, Spain under International Astronomical Union (IAU) exchange programme of Astronomers for three months, October-December 1999 and University of Allepo, Allepo, Syria, 1992 for three weeks under UGC program.

DR. S. K. BHATTACHARYA
President
Section Medical Sciences
(including Physiology)

Dr. Sujit Kumar Bhattachaya, presently Director, National Institute of Cholera and Enteric Diseases under Indian Council of Medical Research and Officer-in-charge of the ICMR Virus Unit was born on January 15, 1950 at Calcutta. He did his MBBS and MD (General Medicine) from the University of Calcutta. He was awarded Guest Researcher by Japan Health Sciences Foundation and worked at the National Children's Medical Research Centre in Tokyo. He was also awarded post-doctoral Fellowship from NIH, USA (not availed). He is an internationally recognized authority in the field of health research particularly in the field of clinical and epidemiological research, both basic and applied. He has undertaken several clinical trials of newer drugs and vaccines including cost effectiveness trials with international callaboration. Dr. Bhattacharya has contributed significantly in the research on various aspects of diarrhoeal diseases, HIV/AIDS, hepatitis and leishmaniasis. He has publised more than 280 papers and 13 book chapters in reputed international journals. Along with his colleagues, Dr Bhattacharya for the first time identified a new cholera pathogen named as *Vibrio cholerae* O139 Bengal and designated it as another form of cholera which was recognized by World Health Organization. He has been instrumental in describing the epidemiology of newer diarrohoeal pathogens. He has undertaken a number of drug trials on Cholera, Shigellosis and Visceral Leishmaniasis. He is recognized both nationally and internationally for his significant research contributions in diarrhoeal diseases, HIV/AIDS and lieshmaniasis. He is a member of several committees of the World Health Organization e.g. Global Vaccine Research Forum, Geneva and International Vaccine Research, Geneva, cholera Vaccine group. He is a nember of the Product Development Team (PDT) for Leishmaniasis of TDR, WHO, Geneva. Member of the Special Technical Advisory Group (STAG) of WHO (SEARO) for Elimination of Kala-azar from Indian Sub-continent. He has worked in a developing country setting (India) throughout his scientific career. Recently, he was engaged as an International Consultant by Asian Development Bank (ADB) for 2 months and worked in Colombo, Sri Lanka to develop an Emergency Rehabilitation Plan for Infectious Disases (SARS). Dr. Bhattacharya was awarded Ranbaxy Science Foundation Award 2000 in the field of Medical Sciences. He was also awarded B.C. Guha Memorial Award of Indian Science Congress Association in 2005 and Remendra Sundar Sinha Memorial Award of the Physiological Society of India in 1996. He is a Fellow of National Academy of Science (FNASc), Allahabad ; Fellow of the National

Science Academy (FNA), New Delhi ; Fellow of the Indian Public Health Association (FIPHA) ; Fellow of the National Academy of Medical Sicences (FAMS), New Delhi ; and Fellow of West Bengal Academy of Science & Technology.

PROF. P. CHAKRABARTI
President
Section of New Biology
(including Biochemistry, Biophysics & Molecular Biology and Biotechnology)

Professor Parul Chakrabarti (d.o.b. June 22, 1939) obtained her Ph. D in Chemistry from Calcuta University (1964) and worked at Bose Institute, Calcutta as a faculty member. After spending a year at the State University of New York at Buffalo, where she worked on the chemical modification of nucleic acids and studied their biological effects on various cellular processes, she moved to Massachusetts Institute of Technology to work with Prof. Har Gobind Khorana, N. L. on membrane biology. After about 5 years, Professor Chakrabarti returned to Bose Institute in 1975 and initiated research on membrane biology, an area in which she continues to work till today. After her return to Bose Institute Professor Chakrabarti served the Institute in various capacietis : Professor of Chemistry (1980-2001) ; Chairman of the Chemistry Department (1987-'88 & 1991-'92) ; Acting Director (1991-'92) ; Emeritus Scientist (CSIR) (2002-'04) and currently an honorary Professor. She is also the honorary Research Advisor to Bengal Tuberculosis Association. Prof. Chakrabarti has served a couple of times as short-term advisor to the world Health Organization on Tropical Diseases. Professor Chakrabarti has been able to establish in Bose Institute a laboratory for frontline research in mycobacteria which is now internationally recognized for its pioneering contributions. The laboratory is also well known for excellenent in membrane biology. Professor Chakrabarti has visited a large number of renowned scientific orgnizations/universities in USA, Canada, UK, Europe, Russia, South America, Africa, Japan, Australia, and New Zealand either as a visiting scientist/professor or to attend international conferences/symposia to chair session or to deliver invited lectures and also in connection with collaborative research programs. Professor Chakrabati has served on the Task Force and as expert in the area of Modern Biology for various national funding agencies and leading institutions in India. She is a member of the American Society of Microbiology, the Society of Biological Chemists (India), Indian Chemcial Society & Indian Photobiology Society ; a Fellow of the National Academy of Sciences, Allahabad and a founder fellow of the West Bengal Academy of Sciences and Technology.

Professor Chakrabarti has guided 30 Ph. D students and 20 post-doctoral fellows and authored more than 150 original reseach papers and chapters in 5 books.

PROF. DR. V. K. F. GUPTA

President

Section of Physical Sciences

Prof. Dr. Vitthal Kumar Farkya Gupta obtained Master's Degree in Physics from Vikram University, Ujjain, 1961. Later, he joined Madhya Pradesh Educational services and served Government PG Science College Jabalpur, Holkar Science College Indore and Govt. PG College Mandsaur. Prof. Farkya was the first Ph. D of the Faculty of Engineering of Indore University, Indore. He was conferred Ph. D degree on his Thesis on "Dielectric Investigation of Plasma" in the year 1972. Prof. Farkya later joined Jabalpur University, Jabalpur as Reader in 1980 and then Professor in Deptt of Physics. His research is diversified in the areas of dielectrics, high frequency measurements, remote sensing, semiconductor devices, energy, environment and biomaterials. Prof. Farkya guided 21 students for their Ph. D thesis and M. Phil dissertations. He has publised around 250 research papers and articles in National and International Journals/Conferences, Symposium and Radio Talks in Hindi. Prof. Farkya has a keen interest in the projects on rural development. He worked as a National service scheme (NSS) project officer and took several projects and completed in the village Doodhiya and Datoda near Indore. Prof. Farkya was appointed coordinator for remote sensing applications for Madhya Pradesh universities in the year 1985 by Madhya Pradesh council of Science and Technology and R. D. University Jabalpur and Govt of Madhya Pradesh. Prof. Farkya woked in a large number of academic bodies, editioral board of 'Physics News' for two years (2001-2002) and selection committees. He chaired large number of sessions in conferences/ symposia. Prof. Farkya is associated with ISCA for the last 30 years or more and worked as a Recorder in the sessions 2002-2003 and 2003-2004 also Prof. Farkya completed several research projects awarded by UGC and CSIR. He is currently engaged in development of new semiconductor devices based on solar energy for rural development.

PROF. S. P. VIJ

President

Section of Plant Sciences

Professor Suraj Prakash Vij (b. November 8, 1940) received his early education at Amritsar,

and obtained M.Sc. (Hons. School) and Ph. D. Degrees from Panjab University, Chandigarh. He joined his alma mater as a lecturer in the Botany Department in 1965, and was promoted as a reader in 1979 and as a professor in 1988. From 1997-2000, he guided the affairs of the department as its Chairman. He has been actively engaged in research and development of Indian orchids. Besides guiding over 30 doctoral students, he has imparted training in scientific development and cultivation of orchids to a large number of enthusiasts and entrepreneurs. His analytical and thought provoking studies have won him international acclaim as a poineer in Indian orchid research. He has elucidated the chromosomal basis of morphological diversity, identified cytogenetic and morphogenetic trends of evolution and brought out the importance of mycorrhizal endophytes in conservation related programs in orchids. His findings have highlighted the significance of weakly developed barriers of reproductive isolation; an inbuilt mechanism for conservation and modification of genomes; inherent polyembryonic potential of orchid seeds and their ability to germinate before reaching maturity; and dependence of ovule development on pollination stimulus in these plants. These findings have a direct bearing not only in tracing the evolutionary history of orchids but also in furthering their economic potential. The micro-propagation techniques developed by him have been widely adopted and are considered to serve as starting point for future investigations in orchids. Prof. Vij's publications (175 papers and 4 books) have been well received and cited frequently in orchid literature. His book 'Biology, Conservation and Culture of Orchids' is widely considered as an excellent referral work. Prof. Vij has travelled abroad extensively for consultation and research. He has been a Keynote/Guest Speaker and Chairman at several international Orchid Conferences/Symposia, and has contributed to the growth and development of orchid science as member of several scientific bodies including the Orchid Specialists Group, Species Survival Commission, IUCN, and Asia-Pacific Orchid Main Committee. He is an elected Fellow of the National Academy of Sciences, Punjab Academy of Sciences, and Linnaean Society. He is also Vice-President, International Society of Plant Morphologists. Prof. Vij was invited to joint the National Research Centre on Orchids, Pakyong, as the Founder Director. He is the Founder Secretary of The Orchid Society of India, and editor of Soecity's publications—The Journal of the Orchid Soecity of India and Orchid News. In recognition of his contributions to the art and science of orchidology, a qaudrigeneric hybrid (Potinara Suraj Parkash Vij) and a natural species (Liparis esspeevijii) have been named after him. Most recently, he has been conferred with 'The Life Time Achievement Award' by TOSI.

KNOW THY INSTITUTIONS

ALL INDIA INSTITUTE OF HYGIENE AND PUBLIC HEALTH, KOLKATA

The All India Institute of Hygiene and Public Health (AIIH & PH), Kolkata, a pioneering organization of the Government, was established on 30th December 1932 with the assistance of Rockfeller Foundation. It is, in fact, the oldest school of Public Health in the SouthEast Asian countries devoted to Post-graduate Teaching and Research in various disciplines of heath intelligence and health services. The Institute was mandated for development of human resources in the field of public health, which it continues to pursue as a leader. The Institute is also entrusted with the responsibility of undertaking various research projects pertaining to public health systems in the country. It plays a key role in advising various health measures to combat public health crises that arise from time to time. It is also the nodal organization for administering Yellow Fever Vaccine.

The chief objectives of the Institute are :

(a) To develop health manpower by providing post-graduate training facilities of the highest order.

(b) To conduct research directed towards the solution of various problems of health and diseases in the community.

(c) To undertake fundamental and operational research to develop methods of optimum

utilization of health resources and application of the findings for protection and promotion of health care services.

The Institute has 11 academic departments and 2 field practice areas at Urban Health Centre, Chetla, Kolkata and Rural Health Unit & Training Centre, Singur, Dist. Hooghly. Under the aegis fo these departments and field practice units, various training courses complemented with exhaustive field programs and workshops are conducted by highly qualified and experienced teaching faculties. To cater to the needs of the students, faculties and other users, the Institute also maintains a reference library especially on health sciences. Two hostels, one for men and another for ladies, are located in the vicinity of the main building of the Institute to accommodate students & guests. Another hostel is also located at Rural Health Unit & Training Centre, Singur for this purpose.

Also, the International Agencies like WHO, UNICEF, ICEF, UNDP provided funds to this Institute to carry out various projects/research activities in Public Health & Hygiene from time to time.

ACADEMIC EXCELLENCE

The Academic record of the institute is quite good and significantly encouraging. The performance of the students for the last academic year and almost similar performance for the past period indicates superb academic excellence and efficiency of the Institute. The Institute, on the average, registered a record success rate of students by about 85%. This has been made possible by providing the best training & teaching facilities to its students with the assistance of well qualified & highly experienced in-house faculty through its academic departments and the field practice units. To ensure the academic excellence and to improve the quality of teaching standard, reputed experts in the area of public health are also invited as guest lecturers and help students familiarise with current development therin. In the current academic session 120 students were admitted in different educational programmes being conducted by the Institute. In the last annual examination for which results are published, in all 132 students appeared in the examination of the various courses, out of which 116 students passed out successfully. This amounts to a success rate of nearly 88%, which indicates a commendable academic achievement of the Institute.

MAJOR ACTIVITIES

The Institute, as one of the major activities, organized various training programmes/ workshops/seminars/training camps etc. in the current period to fulfill its mandate towards development of specialised manpower in the area of health and hygiene. Several multipurpose research projects related to the solution of various problems of health and diseases in the community sponsored by Central Govt., State Govt. and some national & international organizations were also carried out by the Institute. Some of these activities and significant achievements thereon that took place in the year 2004-05 are highlighted below.

TEACHING AND TRAINING ACTIVITIES

During the period under review, the Institute was engaged in conducting one MD course in Community Medicine, two master degree courses (MEPH & MVPH) and seven post graduate diploma course (DPH, DMCW, DIH, DPHN, DHE, Dip-diet & DHS) and several short-term orientation and trainng courses. The students

came from various parts of India. This is the only Institute in India which provides multi-professional health training facilities for various disciplines such as doctors, engineers, nurses, nutritionists, statisticians, demographers, social scientists, epidemiologists, micro-biologists and other allied health professionals. The varying training needs were met by providing basic essentials relating to different disciplines through appropriate teaching methods. Guest lecturers were also invited from amongst the experts in the various branches of health sciences.

FIELD PRACTICE UNITS

Two Field Practice Units viz. Urban Health Centre, Chetla, Kolkata and Rural Health Unit & Training Centre, Singur, Hooghly (W.Bengal) are operating very smoothly under the direct control of AIIH & PH. Besides the field practice services offered to the students of AIIH & PH, the field units are also providing excellent clinic based preventive, promotive & curative services to the community. The Rural Health Unit & Training Center at Singur covers a population of 0.90 lakhs (approx.) consisting of 62 villages, whereas the UHC, Chetla, Kolkata covers a population of about 1.18 lakhs spread over an area of 3.9 sq. Kms. The Centre at Singur also provides health care services through its two Primary Hleath Centers and four Sub-centers. Both the field units are also carrying out studies and organizing workshops on health related aspects.

LIBRARY SERVICES

The Institute is having a large reference library, which offers excellent services on health information and other related matters for various users. It occupies a unique position in the academic and pharmaceutical circles of the city. The library services are provided to the students & faculty of this Institute and other educational institutions in and around. A vast number of clientele comprising pharmaceutical community, teachers, technologists, industrialists and lawyers, Govt. officials, students, research scholars from different colleges and universities & educational institutions visit the library to have their required information. The Library is having about 16,000 books and 35,000 journals. The stock of the library is constantly being enlarged and enriched every year by acquistion of books & journals, periodicals, etc. During the reference period about 450 books, 55 reports have been added to the stock of the Library. About 72 journals including Global Publications of WHO, British Medical Journals, JIMS etc. are currently being subscribed by the Library. With a view to ensuring better and effective services to the users, the services system of the library is being modernized with the help of the state-of-the-art facilities. The work in this direction is going on very smoothly and speedily.

IMPORTANT ACTIVITIES

- As a nodal organization for administering Yellow Fever Vaccine, this Institute vaccinated 380 persons from 1st January 2004 to 30th November 2004. The Institute also carried out pathological, bacteriological & chemical tests of individual and water as and when situation demanded. As an HIV surveillance centre, the Institute also tested 351 samples from different categories of individuals for detection of HIV. In addition, 299 water samples have been processed out of which 74 were found fit for human consumption.
- The Department of Preventive and Social Medicine of this Institute is recognised as

WHO collaborating centre for Disaster Preparedness and it conducted several educational and research activities in collaboration with the State Governments of the North Eastern states.

- The Institute through the faculty and staff members continues to support various national/international health and family welfare programmes. It is worthwhile to mention that like the previous years, the Department of Public Health Nursing facilitated the observance of the World Breast-feeding Week during the first week of August 2004. On the occasion, the department organized eight interactive sessions with mothers of rural community on breast feeding awareness, problems and solutions including health play/role play by the Nursing personnel on the theme—**Breast feeding in a Globalized World—for peace and justice.**
- The Institute also conducted the following programmes for the benefit of the communities.
  - Health Educational Intervention for mental health promotion in a Rural area in West Bengal from 24th March to 26th March 2004.
  - Exhibition on "Exclusive Breast Feeding—The Gold Standard" at Rhu & Tc. Singur on 26th August 2004.
  - "Empowering communities"—Participatory Techniques for Community—Based Program Development at Barajori. Ghatshila in East Singbhum. Jharkhand in CDP area of Bharat Sevashram Sangha and Union Ministry of Tribal Affairs for about 9000 primitive tribal population 28th & 29th Auguest, 2004.
  - Community Initiative for Breast Cancer Awareness. A collaborative effort of the Deparment of Health Education. AHH & PH and IMA Kolkata INAUGURATED on 15th October 2004.
- The Institute also rendered consultancy services and provided technical guidance in the areas of Public Health and Hygiene at various forums through representations of its faculty members in various regional, national & international conferences/workshop/seminars, etc. as resource persons or experts. In many of such forums. AIIH&PH faculty and organizational structures were acknowledged by concerned Organization and Association.
- With a view to enhancing the efficacy and the academic excellence of the Institute, nationally & internationally reputed experts in the area of public health, eminent visiting professors and scientists were also invited to share the information with the faculty and students of the Institute. It is worth-mentioning that Hon'ble Minister of Health & Family Welfare. Dr. A Ramdoss visited this Institute and had very fruitful discussions with the faculty on 5th August 2004. The Hon'ble Minister appreciated the key role of the Institute and its valuable contribution in the matter of promotion of public health and hygiene.

The curricula for the courses offered by the Institute has been upgraded and revised to suit the ever-growing needs of the comminity & change and advances in science & technology.

For Further Details *: Director*
All India Institute of Hygiene and Public Health,
C. R. Avenue, Kolkata - 700073. Tel : 2241-3954

Conferences / Meetings / Symposia

Date	Topic	Contact
24-27 January 2006	International Conference & workshop on **Innovations and challenges in Bio-Technology** : BIOVISION-2006 Chennai.	**Organising Secretary** Department of Industrial Biotechnology, BIHER 173, Agaram Road, Selaiyur, Chennai-600073, Tamilnadu. E-mail : biotech_bharah@yahoo.com
28-29 January 2006	Nineteenth National Convention of **Metallurgical and Materials Engineers on 'Emerging Technologies in Iron and Steel-making"** : Ranchi	**The Honorary Secretary** Jharkhand State Centre IEI, Engineers' Bhawan, Nepal Kothi Campus, Ranchi 834 002 e-mail : ieiranchi@yahoo.co.in
2-3 February 2006	National Symposium on **Biotechnology and Insect Pest Management** : Chennai	**Dr. S. Ignacimuthus,** Director, Entomology, Research Institute. Loyola College, Chennai-6000034 E-mail : eri_lo@hotail, com
10-11 Feburary 2006	National Conference on **Intelligent Integrated control** and **automation, Coimbatore**	**Mrs. M. Sundarambal.** Organizing seretary, Coimbater Institute of Technology Caim bater 641014 E-mail : iica 2006 @yahoo.co.in.
24-25, February 2006	Seminar on **Alternative Sources of Energy and Quality Power–Vision 2020 Jaipur**	**The Honorary Secretary,** Rajasthan State Centre, IEI, Gandhi Nagar, Tonk Road, Jaipur 302 015 E-mail : ieijpr@eth.net

Date	Topic	Contact
17-19 May 2006	12th IFAC Symposium on **Information Control Problems in Manufacturing,** 'Saint-Etienne, France.	**INCOM 2006 Secretariat** Ecole, Nationale Supérieure des Mines de Saint-Etienne 158, cours Fauriel–42023 Saint Etienne-Cedex 2- France E-mail : incom06@emse. fr
20-23 June 2006	36th International conference on **Computers Industrial Engineering,** Taipei, Taiwan	**Prof. Daniel Sheu** Program Chair, Associate Professor of Dept. of Industrial & Engineering Management National Tsing Hua University E-mail : dsheu@nthu.edu.tw
18-20 July 2006	10th International Cogress on **Insurance : Mathematics and Economics,** Belgium	**AFI Leuven Research Center** Katholieke Universitet Leuven Naamsestraat 69 3000 Leuven, Belgium E-mail : ime2006@kuleuven.be

ANSWERS TO "DO YOU KNOW?"

A1. with their feet
A2. Approximately 100 billion tons.
A3. A cow can climb but cannot go down.
A4. About 200 metres.
A5. In planet Naptune.
A6. 5000 litres...
A7. Assuming 18,000 steps a day and an age of 76-77, it comes to 22.5 million km i.e 5 roundtrips of the world.
A8. Louise brown.

S & T ACROSS THE WORLD

BIOINFORMATICS

According to many perceptive observers of the technological scene, the present century is going to be the century of bioinformatics, where biotechnology interacts with information technology, and Sikkim State appears to have grasped the seminal role that biotechnology is going to play in future.

Sikkim State is exceptionally rich in flora and fauna and the Sikkim Biotechnology Information System (BITS) has been set up by the State Government as a distribution network in the field of biotechnology and molecular biology. It has developed a web based data base covering the taxonomy, distribution, economic importance, etc. of a wide variety of flora and fauna in the State. This database will be extended to other fields in the sphere of biotechnology in due course.

(State Council for S & T Sikkim, June 2005)

SCIENCE-DRIVEN SUPERCOMPUTER

Till recently, computers were basically science driven and machines with names like ENIAC and MANIAC. These ran on vacum tubes, filled up large spaces, and were designed mainly to solve scientific problems. However, that era was shortlived, and with the advent of PC's desktops and laptops, far more powerful machines have come into the market.

These machiens are not optimised for scientific computing as their applications do not access memory the same way that scientific applications do. Indeed it has been found that even the ability of present day supercomputers to carry out scientific applications is dropping steadily.

Such problems are, however, not faced by the Japanese custom-designed supercomputer called Earth Simulator with its scientific sponsors principally from Japan's Marine Science and Technology Centre and contributing computer vendors (led by NEC Corporation, closely collaborating to build a machine optimized to investigate geosciences and environmental questions on a global scale. This computer is capable of performing 35.6 teraflops (35.6 trillion operations per second) and is almost five times faster than the next fastest machine. It has inspired computer scientists to have a closer look at the role of super computers in science.

(Science@Berkeley Lab, Mar 31, 2005)

LUMINESCENCE FOR SAFETY AND SUSTAINABILITY

EnviroGLO Terrazo surfaces offer designers and architect a chic new option to combine safety with sustainability.

Through a proprietary process, post-consumer glass coated with luminescent paint is crushed into small pieces with virtually no sharp edges. Mixed into an epoxybinder, the result is environmentally friendly and dazzling glow-in-the-dark Terrazzo. Non-toxic and non-radioactive, photo luminiscent EnviroGLO Terrazzo charges by exposure to light, and if all power fails, it glows in the dark.

Responding to the World Trade Centre Building Code Task Force recommendations, New York's new building codes now mandate photo luminiscent glow-in-the-dark markings for

exit doors and stairs in all buildings over 75 feet tall. EnviroGLO Terrazzo flooring and stairs can add to the safe exit patrons and employees from buildings that have just lost power.

(EnviroGLAS Products, June 21, 2005)

EXPLORING PROTEIN UNIVERSE

Based on the total number of known life forms on earth, it is estimated that there are 50 billion different types of proteins existence, and it is possible that the protein universe could hold many trillions more.

Scientists have been at their wit's end to identify the most promising regions to locate these proteins but now a 3-D map has been prepared that brings order to the protein universe through a manageable organization.

This protein structure space map has been prepared on the basis of the distribution in 3-D space of the 1898 unique protein structures. Proteins with similar structures and functions are clustered together in the map. Where the structure of a new protein is identified it can be placed in the appropriate location on the map to reveal its neighbours and its evolutionary history. This information is then used to predict the protein' function. It is believed that this map is the best available method at present for predicting the functions of new proteins whose functions cannot be predicted from their amino acid sequence information or structural similarity.

(Berkley Lab, Apr 18, 2005)

SUMMARY OF PROGRAMMES

93rd INDIAN SCIENCE CONGRESS January 3-7, 2006

Theme : Integrated Rural Development : Science and Technology

JANUARY 3, 2006 TUESDAY	JANUARY 4, 2006 WEDNESDAY	JANUARY 5, 2006 THURSDAY	JANUARY 6, 2006 FRIDAY	JANUARY 7, 2006 SATURDAY
9:30 am -12:45pm **Inauguration by Hon'ble Prime Minister of India** **Award Lecture – Amartya Sen** Nobel Laureate (Main Pandal)	8:45 am – 10:45 am **Public Lecture III** (Main Pandal) MS Swaminathan **Special Lecture I** (Main Pandal) Richard R Ernst Nobel Laureate 11:00 am – 1:00 pm **Plenary I** Science & Disaster Management **Panel I** Global Science & Rural Development in the SAARC Region **Plenary II** Protecting and Prospecting of Bio-diversity and Agri-diversity 10:00 am onwards ***Group Meeting I*** *NGOs, Panchayat Raj Institutions, Farmers and Public* ***Group Meeting II*** *Media Perspectives of Rural Development*	10:00 am – 11:15 am **Inauguration of the Programme by H.E. President of India** (Main Pandal) 11:30 am **Inauguration of National Virtual Congress by H.E. President of India** (Main Pandal)	8:45 am – 9:30 am **Special Lecture II** (Main Pandal) PM Bhargava 9:45 am – 11:45 am **Plenary IV** Rural Energy **Plenary V** Health, Sanitation and Communicable Diseases **Plenary VI** Public-Private and Academia-Industry Partnership 11:45 am – 1:15 pm **Award Lectures** (Main Pandal) • Raj Kristo Dutt Memorial Award Lecture • BC Guha Memorial Award Lecture **Panel IV** Sustainable Water Security *10:00 am onwards* ***Special Session II*** *Open Access*	8:45 am – 9:30 am **Special Lecture IV** (Main Pandal) David Hekkel 9:45 am – 11:45 am **Plenary VII** Rural Education Knowledge and Skill Empowerment **Plenary VIII** Harnessing Frontier Sciences/Technologies **Plenary IX** Management of Climate and Environment 11:45 am – 1:15 pm **Panel VI** Centenary of Agricultural Education in the Sub-Continent **Panel VII** Women Empowerment **Panel VIII** Sustainable Livelihood (off-farm and on-farm employment)
1:00 pm – 2:00 pm **Lunch** (Food Court)	1:00 pm – 2:00 pm **Lunch** (Food Court)	1:00 pm – 2:00 pm **Lunch** (Food Court)	1:00 pm – 2:00 pm **Lunch** (Food Court)	1:00 pm – 2:00 pm **Lunch** (Food Court)
2:00 pm – 3:00 pm **Public Lecture I** (Main Pandal) CNR Rao 3:15 pm – 4:15 pm **Public Lecture II** (Main Pandal) RA Mashelkar 4:15 pm – 4:45 pm **Tea Break** 4:45 pm – 6:00 pm **Interface between Nobel Laureates, World Food Prize Awardees, Nation Builders, Eminent Scientists and Young Scientists** (Main Pandal) 7:00 pm – 8:30 pm **Cultural Programme** (Main Pandal) 8:00 pm – 9:30 pm **Dinner** (Food Court)	2:00 pm – 5:00 pm **Sectional Sessions** (Ag. College) ***Round Table I*** *Science Collaboration between India and EU-7th Frame Work Programme for Research and Technological Development and Demonstration* 5:15 pm – 7:15 pm **Panel II** Global initiatives to address Millenium Goals – Hunger, Poverty Alleviation, Global Food and Nutrition Security **Plenary III** New Biology/New Biosciences **Panel III** Coastal Zone Management 8:00 pm – 9:30 pm **Dinner** (Food Court)	2:00 pm – 5:00 pm **Sectional Sessions** (Ag. College) ***Special Session I*** *(APARD Audi.)* *Mission 2007 Every village - A knowledge centre* 3:00 pm – 4:00 pm **Interaction of Children with H.E. President of India** 5:15 pm – 6:15pm **Public Lecture IV** RA Chidambaram 6:15 pm – 7:15 pm **Public Lecture V** Wangari Mathai Nobel Laureate 7:00 pm – 8:30 pm **Cultural Programme** (Main Pandal) 8:00 pm – 9:30 pm **Dinner** (Food Court)	2:00 pm – 5:00 pm **Sectional Sessions** (Ag. College) *2:00 pm onwards* ***Forum Meeting*** *Forensic Sciences and Society* 2:00 pm – 4:00 pm **Panel V** Water : Biophysical and Socio-Economic Dimensions of Rural Food Security in the developing countries 5:15 pm – 6:15pm **Public Lecture VI** (Main Pandal) Dr. N.Jaya Prakash Narayan 6:15 pm – 7:00 pm **Special Lecture III** (Main Pandal) Ulrich Kopke 7:00 pm – 8:30 pm **Cultural Programme** (Main Pandal) 8:00 pm – 9:30 pm **Dinner** (Food Court)	2:00 pm – 5:00 pm **Sectional Sessions** (Ag. College) 5:30 pm – 6:30 pm **General Body Meeting** (Main Pandal) 6:30 pm – 7:30 pm **Valedictory** (Main Pandal) 8:00 pm – 9:30 pm **Dinner** (Food Court)

LIBRARY SERVICE
The Indian Science Congress Association
14, Dr. Biresh Guha Street, Kolkata-700 017

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Indian

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Foreign

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American Scientist
Endeavour
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Journal of Environmental Planning and Management
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Indian Journal of Physics
JIMA
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WMO Bulletin
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भारतीय विज्ञान कांग्रेस संस्था

14, डा० बिरेश गुह स्ट्रीट, कोलकाता 700017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

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Website : http://sciencecongress.org

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12. New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)
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