EVERYMAN'S SCIENCE

Vol. XLIV No. 1 (April '09 – May'09)

COVER PHOTOGRAPHS ***(From the Top)***

Past General Presidents of ISCA

1. Prof. S. K. Mitra	**(1955)**
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4. Prof. M. S. Thacker	**(1958)**
5. Dr. A. L. Mudaliar	**(1959)**
6. Prof. P. Parija	**(1960)**

Printed and published by Prof. S. P. Mukherjee on behalf of Indian Science Congress Association and printed at Seva Mudran, 43, Kailash Bose Street, Kolkata-700 006 and published at Indian Science Congress Association, 14, Dr. Biresh Guha Street, Kolkata-700 017, with Prof. S. P. Mukherjee as Editor.

Annual Subscription : **(6 issues)**

Institutional Rs. 200/- ; Individual Rs. 50/-

Price : Rs. 10/- per issue

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EDITORIAL

Contemporary human culture and life styles are overtly dependent on science. The future will be dependent ever more. This calls for a society that is scientifically and technologically literate. The developmental persective of Indian society, too, depends on the creation of a scientific temper among the youth, so that the next generation can leapfrog over the technological lag that now prevails. In short, India needs committed scientists who can deliver and who can think creatively, scientifically and with ingenuity.

The prospective scenario, however, seems a bit different. The 1960's craze for academic careers in the sciences and in fudamental research has nearly vanished. No doubt, young hopefuls still adorn the portals of the numerous engineering colleges, but their target is, more often than not, to land secure jobs. Frequently, even this career in science/technology is abandoned for a degree in management followed by a non-science related job. In other words, what appears to be the popularity of science through engineering and medicine turns out to be a chimera.

For India to become a world power and a humane society of the future, the trend in aversion to a career in science needs to be reversed. No doubt the government has taken some measures to counteract the present trend by instilling scholarship schemes, four-year graduate and five year integrated masters' degrees. But these measures will not alone attract students to careers in science. In fact, raising remunerations of scientists, while necessary, will only serve as comparison markers, but not necessarily produce innovative and committed scientists. What then can be done to ensure that we get scientifically innovative youth in the future ? This certainly calls for soul-searching and examination of the system of science education right from the grassroots.

One of the main concerns is that of the science curriculum at the school level. Is it appropriate for generating that curiosity for matters scientific among tomorrow's citizens ? Or is it only the capsule of 'knowledge' that the learner is to be filled up with ? Is this 'knowledge' meant for retention, reflection, application and renovation, or is it to be evaluated through examinations and then discarded ? Is the content and the method of imparting the 'knowledge' interesting and rejuvenating ? Does it make the student want to know more ? Does it make the student want to use the 'knowledge' ?

Should we look around us, in our homes and in our schools, we'll see that what is taught are staid contents, in 'information pills' that are gulped down by the student and regurgitated in examinations. Not much effort is spent in making the knowledge significant and usable or to point out its consonance with everyday life. No encouragement is given to the student to think independently and critically. In fact, this is discouraged as it detracts from the over-weight syllabus and upsets preparations for myriad examinations.

It is no use blaming the teacher for the above contradiction. S/he is usually in a predicament– should s/he concentrate on imparting concepts in interesting and applicable ways, or should examinations take precedence ? Parental pressure too, acts against them. Parents want to ensure that their wards do well in examinations–true learning is usually not their concern. Interwoven with this is the evil of private tuitions, which takes the urge for teaching away from the teacher and makes it a money spinning affair to ensure success of students in examinations.

The other class of protagonists in the teaching profession is the training colleges for teachers. These institutions do not give enough importance

to modern methods of teaching or to challenge traditional mindsets. The new teacher therefore faces his/her class with the same techniques that generations before him/her have used. But changed circumstances and resources call for changed strategies. These require to be propagated. For example, software with computer simulations of experiments need to be used, attractive textbooks have to be written and entertaining general knowledge books too have to be made available.

Science clubs need to generate activities that enthuse students, and students' science projects require more appreciation–yes, almost as much as or more than the song and dances in school cultural activities. Most importantly, a constructivist attitude to teaching has to be generated, so that students are attracted to science instead of being repelled, and be nurtured through student activity and not by dictation by the teacher.

The ball is, therefore, in the court of the teacher educators in science. It is also in the court of the boards of education, which must transform themselves from being mere examining bodies and take curriculum development and implementation in science more seriously. Once an aversion grows, it stays.

To paraphrase T. S. Eliot, "Where's the wisdom we have lost in knowledge ? Where's the knowledge we have lost in information ?"

Here's to the redemption and rejuvenation of science education in India.

Dr. Ambar Ghose

"We know what we are but know not what we may become"
—Shakespeare

PRESIDENTIAL ADDRESS

SCIENCE AND PROGRESS : THE STORY OF RADIO-ELECTRONICS

PROF. S. K. MITRA* D. SC, F. N. I., F. A. S.

I must first express my deep appreciation of the great honour that my scientist colleagues have conferred upon me by electing me the General President of the Indian Science Congress Association.

I also offer our sincere thanks to our Prime Minister for coming to this Inaugural Meeting notwithstanding the innumerable demands on his time. Till year before last the Prime Minister had been attending our Inaugural Meetings as an honoured guest. But, he has since accepted the Honorary Membership of the Indian Science Congress and, as such, is attending today as one of us. The Prime Minister always places Science in the forefront of any plan of national development. His acceptance of our Honorary Membership is a proof—if indeed any such proof is needed—of his belief that in the progress and applications of Science lie the means of fighting the evil combination of poverty, ignorance and disease in our country. This belief of his is shared by all of us, the members of the Science Congress assembled here. But, I am afraid, there are still persons amongst the general public—and a considerable number of them—Who have, at best, a confused idea about the role of Science in the economic uplift of the country. And, even amongst knowledgeable persons, there exists not infrequently, a doubt about the urgency of conducting scientific research in the country. Hence, as one of the objectives of the Indian Science Congress is to disseminate the knowledge of Science and its applications, I would, in the first part of my address, make a few remarks regarding the rationale of this role. What I will say will not constitute a learned thesis and will not contain anything new that is not already known to my scientist colleagues. It will rather be an appeal : an appeal to the general body of intelligentsia of the country to try to understand clearly, without allowing the main issue to be clouded by sentiment, the root cause of mass poverty and the right method of fighting it, and also to give intelligent support to the plan for carrying out the fight—the Five Year Plans adopted by the State.

ROLE OF SCIENCE IN ECONOMIC PROGRESS

Science and National Reconstruction

The economic progress of a country depends on the extent to which its natural resources have been exploited for creation of wealth, that is, for production of commodities of human need. Without such exploitation there may be the curious spectacle of a country which is rich in natural resources but whose people are poor. The spectacle is like that of a man who possesses wealth but who has to live in poverty because his wealth is locked inside a vault and he has not the key to open it. Science provides

* General President, Forty second Indian Science Congress held at Baroda during January 1955.

the key for unlocking the wealth. Speaking without metaphor, Science, enquiring into the laws and regularities of Nature, indicates the methods of utilising the natural resources of the country for the production of the necessities of life and for their efficient distribution. Mere indication of the methods is, however, not enough. To implement the methods indicated one has to do work. And here again Science comes to the aid. Science provides labour-saving devices, power, machineries and tools, for doing the work—devices of all types, those for work involving only muscular effort, for work demanding manipulative skill and, in recent years, even for work necessitating brain effort. Without such aids the rate of production is extremely slow and the country cannot produce enough to become wealthy by any standard.

In the light of the above, the origin of poverty of the masses in India can be put in plain language thus : In order to get the comforts and amenities of life one must work. The amount of work necessary for supplying these, according to modern standard, is beyond the capacity of man and animal power. The western countries employ for this purpose labour-saving machineries. India does not do that to the same extent. Hence India cannot enjoy the same comforts and amenities as the western countries do. If India aspires to attain the status of a rich nation she must adopt the policy of making the fullest use of the natural power and the labour-saving machineries for increasing her production, that is, must industrialise herself. This is plain and simple truth and can be understood by the man in the street. But, strangely enough, when attempt is made to give effect to the policy, difficulties are found to arise. I well remember, in this connection, what I was told more than a decade ago, when I visited a nearby industrial city as one of the members of the Industrial Research Planning Committee appointed by the Government of India. The manufacturers said, "We agree that scientific research will most certainly point the way to increased production. But will there be enough demand for the goods so produced ?"[1] Even today, the same thing is said by the industrialist. We have thus the dilemma : people cannot purchase and support the industries because they are poor and the people are poor because there are not enough industries in the country. Then there is another dilemma. The industrialist asked to rationalise his methods of production says : I am ready to rationalise, but that will throw men out of their jobs and aggravate the problem of unemployment. The reason why these dilemmas arise is that in the policy of industrialisation emphasis is, not infrequently, put on the wrong end. In order to be fully effective industrialisation must proceed in an ordered fashion and not haphazardly. The right order of emphasis should be capital goods (machinery, steel, power plant, etc.), production goods (fertilizer, steel, heavy chemicals, etc.) and consumer goods (light electrical goods, paper, clothing, etc.) industries. If emphasis is laid on the last named ones first, the problem of over-production is bound to arise, because, the purchasing power of the people cannot increase out of nothing. In this connection one may consider the case of agriculture—a major and vital industry of any country (belonging to the last category). Since 80% of our population is dependent on agriculture—pursued primitively with hand and animal power—it is tempting to begin by laying emphasis on mechanisation of agriculture. But one forgets in one's enthusiasm that if mechanisation is pushed too far, without having started industrialisation in other sectors, the agriculturist will be thrown out of employment and, at the same time, the lowered price of his produce will hit him adversely. The lowered price, in fact, will benefit the 20% non-agriculturist and not the agriculturist. If, however, one starts with emphasis on the establishment and expansion of the capital goods and production

1. It is pleasant to note that the industries referred to above have, since, combined to form a Research Association and have founded a fine Research Institute with the cooperation of the Council of Scientific and Industrial Research.

goods industries, then, on the one hand, jobs will be created instead of destroyed absorbing men from the agricultural population, and, on the other, the consumer goods industries will be helped by the supply of proudction materials. The consumer goods industries, at the same time, will receive stimulus by the increasing purchasing power of the workers of the newly created industries. This will be a move in the right direction, right for progressive industrialisation and not in the direction in which industrialisation produces problems of unemployment and overproduction. Such progressive industrialisation will also ultimately bring about the much sought for transition of the economy of the country from one predominantly agricultural to one predominantly industrial.

I hope I shall not be misunderstood as having advocated neglect of agriculture. Agriculture, or for the matter of that, all village industries should have to be fully mechanised ultimately, because, rural economy based on hand-loom and primitive agriculture will never raise the standard of living of the villager above subsistence, though, some of our politicians still dream of effecting this by giving support to village handicraft, perpetuating inefficient and outdated methods of production.[2] What I meant was that by giving prior emphasis to agriculture we shall only be endorsing the policy of the Government of the pre-independence days which had always said that since India is predominantly an agriculture country her salvation lay in improving her agriculture.

Effecting the transition from agriculture to industry is not a simple and easy task and there is no short cut to it. Vast amounts of capital goods in the shape of machinery, power plant, land and buildings will be needed for the purpose. The formation of the necessary capital—if we are to depend on the peoples savings only—will take time, because saving of the people are meagre. The problem is further complicated by the rapid rise in population. There will, in fact, be a race between the increasing earning capacity of the capital formed and the increasing population. If the former wins we shall be richer and richer. If the latter wins we shall be poorer and poorer. And, if neither wins we shall continue to be as poor as we are today notwithstanding our industrial developments. (If population growth is not controlled, then, according to some estimate, the investment rate has to be Rs. 2,000 crores per annum for the next few years to double the national income in 10 years.) Besides, even supposing that the capital is progressively built up and invested, the transition will have to proceed according to a well thought out plan. The developments in the different sectors—agriculture, the various capital, producer and consumer goods industry, power production and social services and will have to be so coordinated that the growth of one will stimulate the growth of others and will ensure the most rapid progress of the country as a whole. This requires planning on a comprehensive scale—Total Planning. Without such a total plan we shall be more planned against than planning. (I hope to be excused for using the word "Total" but I could not find a better substitute.) That the planning, in order to be effective, has to be comprehensive and total was recognised by our Prime Minister even in pre-independence days. In 1938, he accepted the chairmanship of the National Planning Committee set up by the Indian National Congress and worked

2. Those who think in terms of village handicraft may consider the following figures. A man working continuously can wield one-tenth horse-power (H.P.). If he works for 8 hours a day, his output of work in electrical unit is 0.6 kilowatt-hour (1 H.P. = 0.746 K.W.). Assuming that the average man works only 300 days in the year, and that in a population, excluding the sick, the children and old only one-third can be engaged in manual labour, the average output of human labour comes to $300 \times 6 \times 1/3 = 60$ units per capita per year or 1/6th unit per capita per day.

An ordinary electric fan consumes the latter amount of energy in about 2 hours. This shows how poor is the average output of human labour of a country.

indefatigably for it till he was sent to prison—for the eighth time-in 1940. Even in prison he gave much thought to the problem of planning. (See, for example, *Discovery of India,* pp. 332-44). It is, therefore, a matter of great satisfaction that the Planning Commission has been set up by the Central Government. Notwithstanding criticisms, the Commission has achieved significant results in the First Five Year epoch soon coming to a close. After years of food shortage, the country has attained self-sufficiency. But, there is yet no ground for complacency. There are still hungry and half-fed people in the country. We have been able to meet the food demand, but not the food want of the people. We have yet a long way to go to be able to equate want with demand and thus to reach the goal of the plan. But, to reach the goal—no mater how thoroughly the plan is made—it is essential that we have peace—peace not only in the international sphere, but also domestic peace. It is often said that the U.S.S.R. has achieved wonders by her Five Year Plans. A very large measure of this success is no doubt due to the objective thoroughness of the Plans ; but it is also in no small measure due to her having internal peace, no strike, no industrial dispute. In our country also if the plans are to succeed there must be complete understanding and full cooperation between workers of all classess in industry, in business and in every other occupation. The workers—amongst whom I include both employers and employees—must realise that they should, in their own interest, maintain peace and work wholeheartedly for the success of the Plans. Because, wealth and prosperity resulting from the success will benefit and will be shared by both.

Place of Scientific Research

I will next try to answer the question sometimes asked: What is the urgency of establishing research institutes and of carrying out researches in the country, when the fruits of the Applied Sciences, the labour-saving devices and the methods of production, at least those employed in the principal industries, are available in the western countries? The answer to this question is that importation of ideas and goods from abroad — though always necessary — is not enough. Problems arise in connection with the processes of production in even well-established profit-earning industries and also with the utilisation of the natural resources which are peculiar and special to the country concerned. Clear understanding of such problems needs scientific approach and their solution scientific guidance. This is only possible if the country has her own trained scientists and her own research laboratories and organisations. It is also to be noted that, not infrequently, researches concerning the problems and the difficulties to be solved lead to invention of new processes of production, and improvements of the existing ones. And, above all, one must not forget that applications of new scientific principles are almost invariably followed by technological developments which give rise to new industries creating wealth. Part of the wealth so created always finds it way back to the organisations for research and for the training of research and technical personnel. The research activities thus intensified lead to fresh scientific discoveries from which again flow new technological developments providing newer means of creating wealth. This is the process we are witnessing in the western countries, the rising spiral raising their people to giddy heights of prosperity.

The economic and cultural advancement of a country is, in fact, today judged by the number of scientists it engages in proportion to its population. According to the Steelman Report (Report to the U.S.A. President by John R. Steelman, Chairman of the President's Scientific Research Board) the proportion in the U.S.A. in 1956-57 is expected to be about 2 per thousand. This is also the proportion believed to be in the U.S.S.R. For Great Britain the proportion is 1/2 per thousand. According to some authorities the target for a progressive country should be 3 per thousand.

Fortunately, we in India have not been entirely unmindful of the value of scientific research for the economic advancement of the country. For some considerable time there had existed in the country government organisations for research in agriculture, in irrigation, in forestry, in the medical and veterenary sciences, and for surveys in Geology, Botany and Zoology. About a decade and a half ago the Central Government adopted the policy of giving general support to both fundamental and applied researches and established the Council of Scientific and Industrial Research. Also, with the advent of the Atomic Age at the close of world war II, an Atomic Energy Commission was appointed in 1948 for the purpose of developing atomic raw materials, for seting up a nuclear reactor and generally for nuclear research.

Every thinking Indian regards these scientific institutions as assets of utmost value to the country. The C.S.I.R. has been sponsoring researches in the University Laboratories and other institutions, has helped in the formation of Research Associations by some of the industries and, above all, has established a chain of National Laboratories covering a range of subjects in Science and industry. It is very necessary that to extend these activities of the C.S.I.R., the recommendations that have been made by its last Reviewing Committee receive due consideration from the authorities concerned. The Reviewing Committee, be it noted, was greatly impressed by all that has been accomplished and recorded its high appreciation of the devoted efforts of the Director, Scientific and Industrial Research, the late Dr. S. S. Bhatnagar. I would, in particular lay stress on the recommendation advocating the necessity of so orienting the relationship of the National Laboratories and the Institutes with the universities that the whole scientific organisation may be operating in concert. This is because, as the Reviewing Committee has very pertinently pointed out, "The future depends to a great extent on the education by *the Universities* (italics are mine) of young people of high calibre to man the laboratories and to fill, while they are still in full vigour, posts of responsibility."

The country also expects great things of the A.E.C. India, as is well-known, has not a large reserve of coal, the source most widely used for generation of power. In fact, her reserve is extremely small compared either to countries like the U.K. and the U.S.A. which are already highly industrialised or to a country like China which is on the way.to industrialisation. It is, therefore, of utmost importance that sources of power generation other than coal be searched for from now. The only other source which can seriously take the place of coal is atomic energy. It may be noted, in this connection, that the U.S.A., the U.K. and the U.S.S.R. have already begun generating electricity from power derived from reactors, though, the cost is still higher than that generated from coal. It is, therefore, hoped that the most important objective of the A.E.C. will be that of building atomic reactors out of Indian materials and also carrying out researches on economic power reactor development. Undue stress need not be laid on secrecy, because, after all, we shall be carrying out atomic investigations for peaceful ends only; secrecy leads to sterilization by naturally putting the responsibility on the shoulders of only a few.

It is, also hoped that in the Second Five Year Plan, allocation of expenditure on research will be on a scale more generous than what it has been in the First Five Year, which was only a small fraction of the 2.5% of the total expenditure allocated under the heading Miscellaneous. It may not be out of place to refer here to expenditures on research and on organisation of scientific efforts in the U.S.A. and in the industries by the various industrial concerns, the Federal expenditure on research in the U.S.A. is more than 2,000 million dollars per annum. This is exclusive of the huge sums spent on Atomic Energy (more than 400 million dollars) and on Aeronautical Research. In the U.K. the annual government expenditure on research is of the order 225 million

pounds. (In this case the expenditure is inclusive of that on researches in relation to aircraft and to atomic energy development.) Besides, more than 30 million pounds is spent annually by the British industry on research and development within its own establishments. (This is 1947 figures, representing about 0.7 per cent of the total annual value of British manufacture). We in India cannot, of course, expect the Governmental expenditure on research to be as lavish as in the U.S.A. and the U. K., nor in the existing state of our industrial and other developments, we need such large expenditures. It is still felt, however, that the amount allocated for research is small and should be more than what it has been under the First Five Year Plan. With a more generous allocation it will not only be possible to make more generous grants to the Government Research Organization, but also to give liberal aids to such of the individual reserch workers in Universities and in the non-official research institutes, who, by their devoted efforts, have built up centres of research in special branches of Science. Such grants will greatly encourage fundamental and applied research.

I have pleaded thus for increased scientific effort, because, I firmly believe, and, I am sure this belief is shared by the scientific workers of all countries, that principles of scientific discoveries properly utilised for production and distribution, and not for destructive purpose, can provide sufficiency for all.

The Story of Radio-Electronics

As an illustration of what I have said in the first part of my address concerning technological developments flowing from applications of scientific principles contributing to the general progress of mankind, I will, in the second part, tell you the story of the birth and growth of the twin Sciences Radio and Electronics or, Radio-electronics in short. I have chosen this subject partly because I have spent many years of my life in the organisation of its teaching and research and partly because the subject is of great national interest having given rise to one of fastest growing industries of the world, producing goods not only for civilian and industrial use but also for vital defence needs.

Radio-electronics with its innumerable ramifications is too vast a subject for even a brief survey in an address like this. I will, therefore, only touch the highlights. Further, since the subject is of great popular interest, I will try to make the address intelligible to all. It will therefore be somewhat of a popular nature. But, I do not apologise for it. Much of what I will say is well-known to the physicists and radio specialists. But I hope they will have a little patience for the sake of the majority here who may be ignorant of them.

I begin by trying to define the subject Radio-electronics, though, it is difficult.

Radio

The word radio is derived from radiation[3], meaning specially electromagnetic radiation, or, electric oscillations. Radio is the art of communicating messages across space without the use of connecting wires. The message to be communicated may be in simple dots and dashes, in sound of varying pitch and intensity, in writing or picture, or as a living scene.

Radio was born on the day on which Heinrich Hertz, the German scientist produced electromagnetic waves—the carrier of all such messages—by discharging an electrified condenser across a spark gap circuit (1887).

3. The terms *radio* and *wireless* are now used almost synonymously. But it has not been so always. It appears that *radio* was for the first time substituted for *wireless* by the Germans in the articles of the International Wireless Telegraph convention in Berlin on November 3, 1906. It was, however, not until the advent of broadcasting (early twenties of the present century) that the term radio began to be currently used in other countries. The great wireless operating companies in the U.S.A. were "wireless" until 1918. "Wireless" is still in common use in Great Britain.

Electronics

Electronics is the science and the art of controlling the movement of electrons, the light negatively charged particles which surround the massive atomic nuclei. The electrons are easily detached from the atoms and their existence was discovered towards the close of the last century in the course of studying the phenomena of electric discharge in partially evacuated glass vessels (like the modern neon sign tubes).

The discovery of electron cannot be ascribed to any single individual. The many phenomena observed in the course of experiments on electric discharge in glass vessels evacuated to various degrees (carried out mainly at Cambridge, England, by J. J. Thomson and his school towards the end of the last century and the beginning of the present one) could only be explained on the assumption of the existence of free electrons in the vessels. The name *electron* is due to Johnstone Stoney, who, much earlier, had suggested the particle character of electricity (1874).

Neither the discoverer of the electromagnetic waves, nor those of the electron could have foreseen the amazing developments that were to follow these discoveries in the course of a few decades, discoveries made in the course of investigations carried out purely in the spirit of research. In the case of electromagnetic waves it was to check Clerk Maxwell's mathematical deductions on the unity of light and electromagnetism made 23 years earlier, and in the case of electron to understand the composition of atoms.

Radio-Electronics

The spectacular development of the art of radio that we have witnessed, culminating in some of the greatest wonders of the modern age—the radar and the television—has been possible only because of the parallel development of many electronic devices and the utilisation of the same in radio technique. On the other hand, results of many investigations connected with radio circuitry have found their place in the art of electronics and have made possible its many successful applications. The growth of the one has thus helped in the growth of the other. Thus has grown up what may be called radio-electronics, which is radio and electronic techniques at work in new ways and in diverse fields of human activity.

The revolutionary developments that followed Hertz's experiments and the discovery of electron in evacuated glass vessels proceeded in three distinct stages :

In the first stage there was the development and perfectioning of wireless telegraphy. This was in the period between the closing years of the last century and the years immediately preceding world war I.

The second stage began with the invention of two-electrode and three-electrode electronic valves for use in wireless telegraphy and telephony, and thus ushered in the age of radio-electronics. The age also saw the advent of short waves for round the world communication leading to the discovery of the Ionosphere—the radio roof of the world. The stage roughly covers the period intervening the two world wars.

The third is the present stage—the age of Micro-waves-waves in the centimetre range. In them radio-electronics has found an entirely new field of applications.

The future stage, if one may venture to make a prophecy, will be the era of the uses and applications of the element *germanium,* the wonder child of electronics. We are on the threshold of this era. One foresees with a certainty the advent of radio equipments of unbelievably small size replacing many of the cumbrous and heavier ones in the use today. And, at the same time, as it had happened before with a fundamentally new invention—there will open up many new fields of application of radio-electronics.

The First Stage : The Age of Wireless Telegraphy

The story of the first stage of development—the utilization of Hertzian waves for signalling across space—is well-known and needs only a brief

reference. In this stage wireless came to be increasingly used for long distance communication supplementing submarine cable service and, not infrequently, totally supplanting the same. Wireless also was adopted by the steamship companies and by the Navy as a means of communication between two moving vessels, or between a moving vessel and a fixed land station. It was also adopted by the Defence Services as an indispensable aid to army manoeuvre. The technical developments in this stage consisted in the installation of long and very long wave (12,000 to 30,000 metres) transmitters and erection of tall masts carrying extended aerial systems for increasing the range of the service. At the beginning, the electric oscillations were produced by simple adaptation of the Hertzian oscillator. This, however, generated trains of highly damped wave packets, which were not only wasteful to produce, but were also not well-adapted for tuning. Novel forms of spark gaps like the so-called syntonic spark gap were, therefore, devised to minimise the damping. Ingenious devices were also invented to do away with the spark gap altogether and generate continuous oscillations. Thus were evolved high frequency alternators like the one associated with the name of Alexanderson and the arc oscillator like that of Poulsen. Attempts were also made at wireless telephony, that is, transmission of speech as opposed to dots and dashes with some success.

This passing reference to the first stage of development would be incomplete without a mention of the controversy that has arisen in recent years regarding the real inventor of wireless. Popularly, the name of Marconi is associated with this invention. But a few years ago it was claimed that the distinction of being the first man to utilise the Hertzian waves for signalling across space should go to the Russian physicist-engineer Popov. Evidences were produced to show that Popov was not only the first to use earth connected elevated aerials for efficient radiation and collection of electric waves, but also was the first to use them for signalling across space. Counter claims by Marconi's supporters were put forward and the controversy, I am afraid, is still unfinished. Be that as it may, a correct statement of facts concerning the invention of wireless would be to say that of the many scientists immediately following Hertz and interesting themselves in researches on electric waves, there were a few—including Sir Jagadish Chandra Bose in India—who, purely in a spirit of research, had experimented with these waves for signalling across space. But, amongst them Marconi was certainly the first to realise fully the enormous commerical possibilities of the Hertzian waves, and the stream of developments that followed Hertz's work was also mainly due to him.

The Second Stage—Advent of the Three-Electrode Valve : The age of Radio Electronics

The story of the evolution of the three-electrode valve which ushered in the age of radio-electonics is as follows :

In 1883 the great inventor Thomas Alva Edison, while developing his electric lamp discovered that if an isolated metal plate is sealed inside the lamp bulb, an electric current would flow between the incadescent filament and the plate if the plate is made positive, but not if it is made negative. Edison did not follow up this far-reaching discovery of his—the Edison Effect. We now know that the current was due to the flow electrons, emitted by the hot filament, across the gap between the filament and the plate. In 1904, J. A. Fleming an English physicist utilised the Edison effect for constructing the diode or the two-electrode Fleming valve. The diode was put into commercial use by the Marconi Company for detecting wireless signals picked up by the receiving aerial. In 1908, Lee de Forest, an American engineer, introduced between the plate and the filament of the Fleming valve a third electrode (grid) for controlling the flow of the electronic current by controlling from outside the charge on the grid. The "Audion", as this device was called by its inventor, was put into certain uses, but, lay in comparative obscurity for a number

of years. This was chiefly because of its erratic behaviour due to the presence of residual gas inside. Perfectioning of the vacuum and thus making its use more reliable was the work of other investigators, mainly that of Irving Langmuir with the aid of high vacuum pump of his own invention. The revolutionary possibilities of the triode were realised only in 1914 when was invented the feedback principle, by which a triode, correctly connected to a properly designed electrical circuit, could, on the one hand, detect and amplify extremely weak electric signals and on the other could generate electric oscillations.[4] Many of the subsequent improvements and modifications of the triode and the triode circuit were made during world war I by the belligerent nations under pressure of war exigency. These were made known after the war was over in 1919 when the world was presented with a practical system of radio telephony which immediately made possible the operation of long-distance trunk telephony and also paved the way for broadcasting (1923).

An interesting development of very great practical interest also followed. With the release of the triode valve for general use, there appeared on the scene the amateur radio experimenter. To play with, the amateurs were allotted the use of short waves (waves less than 200 metre length) as these were considered useless for practical long-distance communication. The amateurs, however, soon discovered that they could do with these short waves just what, according to the radio *pundits,* they were not expected to be able to do. With power of a few watts (compared to hundreds of kilowatts of commercial stations) and simple homely aerials they began exchanging greeting with fellow amateurs in distant parts of the world. The experts at first received these reports with scepticism. But they could not shut their eyes to facts. They, therefore, began investigating the possible mode of long-distance short wave propagation and were led to the re-discovery of the radio wave reflecting region of the upper atmosphere—the Ionosphere.

The many applications of the triode and of its modifications and of many newly invented electronic devices after the close of world war I, to the promotion of almost every form of human activity—education and entertainment, transport by sea and air, controlling industrial productions, medical therapy, offensive and defensive operations in I and, sea and air and to researches in pure and applied sciences are too numerous for detailed description. I shall make only a passing reference to one, the electronic computing machine.

The history of high-speed electronic computing machine or "giant brains" as they are called, is only about 10 to 15 years old. Every such machine is basically composed of the following units : A computation unit, a control unit, and a memory unit. The first carries out addition, subtraction and division at incredible speed, the second directs and supervises the various operations and the third stores the information and instructions. There are also devices which feed the data and the instructions to the machine and also those which obtain the answers in intelligible forms. The computing unit can multiply

4. A distressing feature of the invention of the triode valve has been the many litigations in the field of patent rights that it gave rise to. In 1904, the Marconi Wireless Telegraph Company of America claimed that the de Forest Radio Telephone Company had no right to manufacture "Audion" as it infringed the patent right of the Fleming valve. In 1916, the Court decided in favour of the Marconi Company holding that the de Forest Company could not manufacture the three-electrode valve without the consent of the other party. Again, there was a litigation starting in 1914 and lasting for twenty years concerning the invention of the "feedback" system. The Court in this case awarded the credit of the invention to Lee de Forest. But it must be admitted that there had been other inventors like Langmuir and Hull of the G.E.C. Laboratories, Arnold of the Bell Telephone Laboratories, Meissner and Armstrong who contributed sub-stantially to the practical development of the "Audion" and to the clarification of its use as an amplifier. Special mention should be made of E.H. Armstrong, Professor of Electrical Engineering in the Columbia University, U. S. A., Who was not only the first to explain clearly the action of the "feedback" principle, but was also the inventor of the super-heterodyne and the super-regenerative circuits and of the frequency modulation system.

4000 times faster than a human computer and can add 30,000 times quicker than a computer. The actual speed of calculation for a particular problem may, however, be much lower because the information has to be supplied to the machine in a particular code. The basic difference is that electronic machine, unlike the usual decimal system, uses binary digit system for calculation. The major fraction of time is taken in encoding the computing matter in a particular fashion suitable for the machine and this time varies from problem to problem. But even then the speed of these machines is enormously greater than what can be achieved by human computers. Due to this high speed, the electronic computers are finding new applications in the fields of science, engineering, and business organization. Amongst their many applications in Science mention may be made of solution of differential equations with large number of variables, investigations in quantum mechanics and X-ray analysis of crystals. In the engineering field also electronic computers are finding increasing applications. Computers are used to analyse results of wind tunnel experiments, analysis of ballistic trials, flutter characteristic of aeroplane wings and complicated optical problems.

The use of computing machines is greatly speeding up the accumulation of knowledge. This accumulation is sure to have repercussion on the Theoretical Sciences. The accumulated knowledge may be expected to lead to the formulation of modifications of the existing theories, making them more powerful.

The Third Stage : The Age of Microwaves

Microwaves—waves in the centimetre range—had been used by the early investigators for their researches on Hertzian waves. Thus, Sir Jagadish Chandra Bose in India used waves as short as half-centimetre for his elegant experiments on the optical properties of Hertizian waves. However, at that time and also for many years afterwards waves of such short length were considered to be of only academic interest. Since the second world war, however, these waves have assumed great importance. The reasons for this are as follows :

Firstly, special types of thermionic valves (involving principles entirely different from those employed in the three-electrode valve) have been invented with which one can generate continuously the extremely high frequency electric oscillations — tens of billions per second — necessary for such short waves. (The ordinary three-electrode valve becomes inoperative at such high frequencies because the time of flight of the electrons from one electrode to the other becomes comparable with the period of the oscillations.) It is pleasing to note that both of the two mdoern types of valve commonly used for generating microwaves—the klystron and the magnetron with cavity resonator—were invented in the University research laboratories, the former by the brothers R. H. and S. F. Varian of the Stanford University, U.S.A., and the latter by J. T. Randall of the Birmingham University, U. K.

Secondly, the waves on account of their short length can be focussed like light waves with compact devices and, when falling on a distant object, e.g. an aeroplane, can be scattered back with sufficient intensity to actuate a distant receiver built with modern refinements.[5] The microwaves can, in fact, be used just like searchlights for locating a distant object in the dark. The transmitter, with its focussing aerial, takes the place of the searchlight and the

5. The energy returned by an object (metallic) is extremely small if the wavelength is large compared to the size. It attains a large value when the wavelength is resonance wavelength—which occurs when the wavelength is of the same order as the dimension of the object. For wavelengths lower than the resonance wavelength it decreases very slowly. The received power P_r is given by

$$P_r = \frac{CP_t SA^2}{R^4 \lambda^2}$$

where R = range ; P_t = transmitted power ; C = a constant depending on the type and efficiency of the antenna; S = a factor depending on the nature and size of the target; A = aperture of antenue; λ = wavelength.

senstitive receiver with the cathode ray device that of the eye. There is, however, the great advantage that unlike the light waves, the microwaves pass freely through fog, haze and clouds. Thus has developed the wonderful technique of Radar (*Radio Direction* and *Range Finding*), with its unlimited variations. One can, for example, follow the movements of an aeroplane from the ground or take from a plane the picture of a landscape hidden by clouds. One can control the course of a vessel or a plane from a distant station. The application of the principle has led to the evolution of the guided missile which can be made to follow the target by controls from the ground. There has also developed automatic control systems with the electronic brain—which does away altogether with the human element. An anti-aircraft gun, for example, will automatically train itself on an enemy plane or a rocket bomb when sighted by the radar, will follow its movements and, as soon as the target comes within its range will fire at it ; if the target does not come within the firing range the gun will move back to its rest position. Perhaps the last word in the perfection of such automatic fighting devices is the supersonic anti-aircraft missile which will follow and hit an enemy target regardless of any evasive movement on the part of the latter. The missile, in fact, is able to manoeuvre on its own throughout the flight, by picking up the scattered microwaves (microwaves which it itself had sent out) from the target.

Of the numerous other peaceful applications of the radar technique, mention may be made of the radar control by which an aeroplane can land safely and rapidly at a rate previously deemed impossible and of the radar picturing of distant cyclones and regions of storm which provide safety aid to sea and air navigation—specially of the latter.

Of the other uses of microwaves, one may mention the easy point-to-point communication along straight distance. Such system of communication has extended greatly in recent years in the U.S.A.

The perfectioning of the marvellous invention of the modern age, the Television, is also a result of direct application of the many new inventions and refinements of microwave and electronic techniques made during world was II. By means of microwave point-to-point communication or, by means of good quality co-axial cables, it will now be possible to relay television programme over long-distances. The day is not far distant when it will be possible to sit in Baroda and see on the television screen topical news pictures transmitted from London, New York or Moscow.

Microwave propagation phenomena through the atmosphere (lower troposphere) has given rise to a new branch of meteorology—the radio-climatology. The propagation is affected by super-refraction caused by special types of height distribution of temperature and humidity in the lower troposphere. Radio-climatology attempts to correlate these phenomena.

The phenomenal development of microwave and electronic techniques that took place during world war II and which paved the way for further spectacular developments during the post-war period, would have taken many decades in normal peace time. The success has been due, on the one hand, to the spirit of team work between different groups of workers—scientists, technicians and engineers that prevailed during the war period and, on the other, to the lavish support from the State.

The Coming Era of Germanium

Germanium, element number 32 in the Periodic Table, was discovered by the German chemist Winkler in 1886 and was named thus after his native land. The importance and the possibilities of Germanium in radio-electronic devices lie in the fact that two mechanisms of electrical conductivity—the *n*-type, due to electrons as carriers, and the *p*-type, due to positively charged "holes" as carriers—can be induced and controlled in this non-conductor by deliberately introducing certain kinds of impurities

into it. (These impurities are of the order of one part in one thousand, and are called "donors" which produce electrons and "acceptors" which produce "holes".) The posibility of the existence of the two types of carriers endows the crystal with termendous possibilities, for, in such an event, the electrical properties of a region having a certain type of carrier may be easily altered by injecting into the same those of the other type. The region of contact of two crystal samples, one with electrons and the other with "holes" as carriers, therefore, becomes a seat of great interest and possibilities. Of these, the triode action is the latest and the most significant.

The story of the successful application of germanium to the invention of the transistor—which can replace a triode valve in many of its functions—affords a striking example of how fundamental research leads to first class practical inventions of far-reaching importance. The story is as follows :

In the Bell Telephone Laboratories at Murray Hill, N. J., U.S.A., there is a research group known as the "Solid State Physics Group". The business of this group for many years had been to investigate the properties of semi-conductors, not merely because of their useful elecrical appliaation, but also because of their rich scientific interest. Now, the usefulness of semi-conductors in electrical application lies in the fact that their indifferent conductivity due to poor supply of current-carrying electrons (of the order one electron per million atom as compared to one electron per atom in a good conductor) can be altered over a wide range—varying about 100 fold—by varying the electronic structure of the material. In the middle of the last decade Dr. Shockley of the Solid State Physics Group had been examining critically the implications of the current theory of electrical conduction in semi-conductors. As a result of this examination, he predicted that the meagre supply of electrons in a semi-conductor ought to be controllable by influencing them with an electrical field imposed from outside without actually contacting the material. Dr. Shockley was quick to realise the practical importance of his deduction and devised some test experiments to check his hypothesis. But, unfortunately, he could not obtain any positive result. The electrons failed to behave according to his prediction. They were somehow trapped in the surface of the material. Dr. John Bardeen, also of the Solid State Physics Group, now attacked the problem theoretically. The theory he developed showed what happened at the surface and also explained many of the observed facts satisfactorily. Further experiments were now carried out in collaboration with Dr. Brattain, another member or the Solid State Physics Group. These experiments led to the invention of the transistor.

Besides its use as transistor—which replaces triode valves in many of their applications—The germanium has two other uses as electronic components. These are, its use as detector as in the old "cat's whisker" crystal radio set and its new commercial use as rectifier.

Germanium junction rectifiers are now used in television sets, in radio receivers, in electronic computers, in "walkie-talkes" and in many other equipments for civil and military use. They replace diode valves in their respective fields quite efficiently.

The transistor is now available in two different types, viz. the point contact and the junction type. It saves space and power and is impervious to blows, shocks and vibrations. Though the transistor has certain drawbacks—its use at high frequencies being limited and its noise figure being large—efforts are being made by research engineers to eliminate them. These efforts have already led to several new developments of which the crystal tetrode deserves special mention. The great future of transistor can be visualized if it is remembered that a transistor does not need an L.T. battery and that its weight and the space it occupies are many thousand times smaller than those of a conventional triode.

It is interestng to note that very little of germanium used commercially is mined. Most of it used at persent is recovered from chimney dust—smelter chimneys of refineries of lead, titanium and zinc in the U.S.A. and industrial chimneys of England. The

dust of the latter is specially rich in germanium as the English coal contains a large proportion of the same.

It is to be noted that properties akin to those of germanium are also exhibited by other materials. Silicon has been extensively used as detector in the microwave region. Very recently announcement has also made of silicon transistors.

RADIO-ELECTRONICS IN THE SERVICE OF SCIENCE

Besides providing new apparatus, instruments and techniques for research in almost every branch of Science pure and applied, radio-electronics has given rise to two new branches of Science, one pertaining to the starry heavens, called Radio Astronomy and other to molecules and atomic nuclei called generally Radio Frequency Spectroscopy (or, Microwave Spectroscopy when it pertains to the molecules.)

Radio Astronomy

The strange discovery that there are heavenly bodies which emit radio waves has opened up a new remarkable chapter of modern Astronomy. The discovery has been possible only because of the invention of various types of electronic valves, which enables one to construct radio receivers so sensitive that they can detect the faintest of radio noise. The study of the celestial radio waves has led to the discovery of hitherto unknown types of astronomical objects.

The nearest heavenly radio source is the sun. The sun steadily emits waves in the metre range (the intensity increasing with the wavelength) even when it is quiet. When disturbed, there is much stronger emission from active spots superposed on the steady emission. Emissions from the disturbed sun are in much shorter wavelength range.

Besides the sun numerous other discrete sources of radiation have been discovered in the celestial firmament. Some of these belong to our own galaxy and some are extra-galactic. One of the problems of radio astronomy is to identify these discrete sources with heavenly objects discernible with big telescopes. Of the discrete sources in our own galaxy, there is one in the constellation of Cassiopeia which is the strongest of all the heavenly radio sources. It has been identified with a hitherto unknown type of nebulous object, the nebulosity consisting of a network of gaseous filaments in violent motion (velocity – 1000 to + 3000 km. per sec.). How strong this radio source is, will be apparent from the fact that estimate shows that if the source were removed ten times far away, it would still appear as a strong source, though, optically it would be too faint to be seen even by the largest telescope. A similar nebulous object, though much less intense, has been observed in the constellation Puppis. Again, a source has been identified with the Crab nebula — the remnants of the supernova of 1054 A.D. Another radio source close to the strong source in Cassiopeia metioned above has been identified with the remnants of Tycho Brahe's supernova, too faint to be observed now.

Of the extra-galactic sources, many have been identified with the normal type of galaxies observed with the telescopes. An interesting result obtained is that the radio flux from these nebulae bears a constant ratio (nearly unity) to the light flux. There are also extra-galactic sources which do not belong to the normal type of galaxies. Thus there is Cygnus A, second in intensity to the strongest galactic Casseopeia source, which appears to be two galaxies in collision. Similar abnormal galaxies have been identified with radio sources in the constellations of Centaurus, Virgo and Perseus.

The radiations from any of the types of sources mentioned above cover a wide range of wavelength from decimeter to several metres. But a source has also been found — the hydrogen clouds distributed in the interstellar space of our own galaxy — which emits "line" radiation of waelength 21 cm. The discovery made simultaneously by Dutch, Australian and American radio-astronomers in 1951 has opened up a new avenue of exploring the remotest parts of our galactic system. It has yielded new and

fundamental information regarding the spiral structure and the rotation of our galaxy extending to distances which could never have been reached by optical means.

A natural question to ask, what is the mechanism of radio emission from the heavenly bodies? Unfortunately, no definite theory is yet available. Only surmises have been made regarding the special features of the objects, photographed with telescopes, which may be associated with the radiation process. Thus, radiation from the quiet sun is believed to be associated with chromosphere; that from the disturbed sun, at the time of solar activity, is associated with "the relatively dense hot coronal material infused into the solar atmosphere". For radio emissions from the numerous discrete sources — galactic and extra-galactic — the only feature common to these objects which point to the presence of some connection with the emission, is the large random and violent motions of the gases in the nebulosities.

The radio stars provide an interesting method of studying the upper regions of the ionosphere which are not accessible to study by the standard "pulse-sounding" method from the earth's surface. The radio stars are found to "scintillate" and the scintillations have been shown to be due to irregularities in the ionosphere. The ionosphere, in fact, makes its presence felt to the radio astronomers, not only by the scintillation phenomenon but also by reflection and absorption of the radio waves emitted by the radio stars. Studies of these phenomena enable one to investigate conditions in the ionosphere which are not otherwise possible.

A few words may now be said regarding the method of studying the celestial radio sources. Two types of apparatus are in use for the purpose — the radio telescope and the radio interferometer. The former is a suitably mounted metallic paraboloid which brings the radio waves to a focus where the receiving antenna is placed. The latter is a suitably disposed system of antenna for producing an interference pattern. Since the wavelength is of the order decimetre to metres, the focusing paraboloid has to be many metres in diameter if a reasonable degree of intensity and resolution is desired. The diameters of the smaller paraboloids in use are of the order 20 to 50 ft., while that of the largest under construction at the Jodrell Bank Station of the University of Manchester is 250 ft.

Study of the heavens by the radio method is being pursued vigorously in the U.S.A. (Naval Research Laboratory, the Universities of Ohio, Cornell, Michigan, Harvard, Carnegie Institution of Washington), Canada (National Reseach Council), Great Britain (Universities of Manchester and Cambridge), France, Holland and Australia (C.S.I.R.O.). It has not yet been started in India. It is perhaps not too much to hope that it will be so in the near future under the auspices of our Council of Scientific & Industrial Research. There will be no dearth of technically trained personnel.

Microwave Spectroscopy

An atom with its electronic structure, or a molecule composed of electrified atoms can act like a receiving or transmitting aerial, that is, it can absorb electromagnetic radiation falling on it or, if suitably excited, can emite the same[6]. Till recently the apparatus for studying the emission and absorption phenomena had been spectro-graphs, the detectors of the electromagnetic radiation being photographic plates, specially prepared if necessary, for the ultraviolet, visible and the near infrared regions, or

6 Transitions between the electronic energy levels of an atom or a molecule give rise to emission or absorption in the visible and ultraviolet regions, the effects of vibration and rotation of the molecule being observed as perturbation effects. Transitions between vibrational energy levels may also be measured directly in the infrared region, the rotational effects appearing as perturbations of the same. The spectral regions involved in the above are studied by optical methods. Absorption spectra due to rotation are now studied directly in microwave spectroscopy, the nuclear effects appearing as perturbation. Finally, nucler effects can be observed directly in the radio frequency region. It is to be noted there are also a few very special cases in which electronic energy-level differences in an atom are associated with microwave spectrum. The best known example of this is that due to the so-called Lamb-Rutherford shift in the spectrum of hydrogen atom.

bolometers for the far infrared regions. No one had thought of using purely electromagnetic apparatus for the purpose, though, it was known that the wavelengths of emission or absorption due to the rotation of molecules fall within the centimeter range or those due to the spins of the nucleus lay in the radio frequency range. But this is exactly what has been accomplished thanks to the many novel radio electronic techniques developed specially in connection with the radar.

Microwave spectroscopy, though barely a decade old, has already added greatly to our knowledge of the structure of atoms and molecules. Study of the shapes and widths of the microwave spectral lines has yielded new information on intermolecular interactions. The well-known phenomena of Zeeman Effect and Stark Effect have acquired a new interest. The theories that had been developed of the phenomena can now be subjected to rigorous tests. Microwave spectroscopy has also made possible more accurate determination of the many nuclear, atomic and molecular parameters, such as, magnetic and quadrupole moments of the nuclei, nuclear spin, atomic masses, inter-atomic distances, bond angles and dipole and quadrupole moments of a molecule.

Microwave spectroscopy will also have many industrial applications. Of these the most extensive one will perhaps be the quantitative and qualitative analysis of chemical compounds and of isotopes.

Radio-Electronics Industry in India

Radio-electronics industry is one of the fastest growing industries of the world. In the U.S.A. it is said to be a 9 billion dollar industry. Every important country in the west has its own radio-electronics industry, specially because of its vital importance to national defence. In India the industry is only in the stage of assembly of home receiving sets with imported components. There are about 200 small-scale assemblers and 18 registered large assembling factories. And, almost all these concerns draw their designs from abroad. Radio industry proper in India is thus in an extremely backward state. This is undesirable not only because we have to spend large amounts of foreign currencies for import of receivers, component parts and valves, but also from the point of view of national defence. In case of any international complication our position would be very insecure. It is, therefore, urgent that steps be taken to establish a full-fledged radio and electronics industry in the country at an early date. Two questions naturally arise in this connection : Firstly, whether the basic materials as are necessary for the industry are available in the country and secondly, whether the demands for the equipment and components produced would be large enough for economic production. In regard to the first, it is to be noted that no country can be completely self-supporting in regard to any industry. For the case of radio and electronics industry in India a survey was made some time ago of the availability of basic materials in the country. The survey, unfortunately, revealed that only about 25% of the basic materials is available. The survey was naturally concerned with the needs for radio sets for civilian use. For specialised and high quality equipment for communication, defence and industrial purposes the specifications are more stringent and hence the availability of basic materials becomes still further restricted. However, the situation is not as hopeless as it appears to be at first sight. With our programme of industrialization, many of the basic materials may soon be expected to become available, and many others may be made available if some of the existing industries are induced to undertake manufacture of these material, which they are, at present, reluctant to do on account of small demands (e.g. magnet steel).

Regarding the sufficiency of demand of radio equipment and components it may be said that the Government Departments alone would import

annually radio goods worth about 4 crores of rupees. The components and valves which go into the production of radio goods of this value may be estimated to be 24 crores of rupees. One is therefore tempted to conclude that economic manufacture of radio components and valves, which is the first step in the establishment of a radio industry, is possible in the country. Unfortunately, the components are many and varied so that the total number of any individual type may not be sufficiently large for economic mass production.

The same remark applies to valves which are imported to the extent of about 2 million in number worth about 40 lacs of rupees. (This excludes transmitting and industrial types of valves.) There are hundreds of types of values in use imported from all over the world. The types become still further varied if we consider the valves used in communication equipment and radar systems which we import. These employ miniature and sub-miniature valves in addition to the normal receiving valves. However, radio receivers may be adapted to the use of such miniature valves, because, they are not more costly than ordinary valves and are capable of performing the same functions. Bearing this in mind it may be possible to standardize the valves to as low as 20 preferred types which would enable various designs of radio receivers to be made with these valves. Hence, the requirement of a particular type of valve would be high enough for economic production with a semi-automatic plant. It is to be noted that high power transmitting tubes employ manual construction and as such the economic figure is considerably lower. It would be in the region of about 500 for valves 500 watts and above.

A beginning has already been made in India for production of radio valves with the establishment of Messrs. Bharat Electronics Limited at Jalahalli, Bangalore[7]. The well-known French firm Compagnie Generate de Telegraphic sans Fil has been appointed technical consultant of the Bharat Electronics. The factory is expected to commence production of miniature valves in the latter half of 1956. It will also undertake the production of components not manufactured by the private sectors, the ultimate objective being manufacture of complete radio communication equipment including radar worth about Rs.4 crores every year for the different Government Departments. The civilian needs appear to have been left out of consideration till now. It is, therefore, suggested that the establishment of radio industries for supplying such needs may be taken up in the Second Five Year Plan.

CONCLUDING REMARKS

Research and Training

In closing my address let me briefly refer to the position of India in regard to research and training in radio and electronics. The position in regard to industries I have just described. We are happy that steps have been taken for the establishment of state-controlled industry which is to supply our vital national needs. In speaking of the position in regard to organisations of research and training, I hope to be excused if I am in a reminiscent mood.

Many years ago — in the twenties — when, as a result of lessons learnt from world war I, the western countries were organising study and research in radio and electronics, two European institutions established for the purpose greatly appealed to me. These were, the Radio Research Board of England and the Heinrich Hertz High Frequency Research Institute of Germany. I often wished that institutions like these were established in India. The former of these was a

7 The figures and data for this section are taken from a note kindly supplied by Messrs. Bharat Electronics Limited.

government sponsored body, the main object of which was to provide a liaison between results of fundamental research carried out in the universities (many of these under the auspices of the Radio Research Board itself) and the many developmental problems faced by the radio industries. The latter was a semi-government institution carrying on both fundamental and applied researches on radio. Knowing the policy of the then government I had, of course, no illusion as to what the fate of a proposal for the establishmnt of such organizations in India would be, coming specially from an insignificant individual like myself. Nevertheless, I always used to conduct a little propaganda whenever an opportunity presented itself in support of my pet ideas with the hope that this would perhaps produce some effect.

Thus, in 1935 when I had occasion to visit the U.K. I got together a number of distinguished British men of Science for discussing the advisability of establishing in India a body like the Radio Research Board of England. Speeches delivered during the discussion, all in favour of its establishment, were reported in India. The late Sir Richard Gregory, Editor of *Nature*, who was one of the guests present at the party, was good enough to write an editorial in *Nature*[8] supporting the idea. When, therefore, I returned to India, some months latter, I was very hopeful that perhaps the opinions expressed by the very distinguished men of Science would have some effect. But I was sadly disappointed. When I approached responsible authorities I was told that research on radio, or for the matter of that of any scientific research of an applied character, could best be carried out in research centers in England and the results, as occasion arose, communicated to India. However, my dream was fulfilled six years later, when, in 1942, the newly formed Council of Scientific and Industrial Research, inaugurated the Radio Research Committee. The Radio Research Committee is now one of the most important Research Committees of the C.S.I.R. It must, however, be said that considering the very wide range of problems to be tackled and the number of schemes sponsored the amount of grant available is extremely inadequate. This should be increased at least tenfold to keep pace with the rapid advance that is being made in other countries.

Regarding the establishment of an independent institute for researches on radio and electronics I had always, when I was Chairman of the Radio Research Committee, tried to impress upon my colleagues the need of it. In 1945, in fact, the Radio Research Committee did actually submit a preliminary plan for the establishment of such an institute. However, it was then thought that researches on radio and electronics could be better carried out in one of the specialised sections of the proposed National Physical Laboratory. I felt therefore, very happy when nine years later I found that my long cherished desire was going to be fulfilled with the laying of the foundation of the Central Electronic Engineerig Research Institute at Pilani, though, I would have liked to see the Electronic Research Institute and the Electronic industrial establishment (Jalahalli) situtated closer together instead of being separated by a distance of more than a thousand miles.

In regard to teaching, it is interesting to note that "Wireless" had for a long time (since 1926 in the University of Calcutta) been one of the elective subjects in the postgraduate Physics course of our universities. But, as the subject advanced rapidly along with electronics, need was felt for introducing teaching in Radio-electronics at the postgraduate level, as an independent self-contained course. This has now been made possible mainly through the

8 Nature, Vol. 137, p. 841 (1936). For a report of the discussion meeting see Science and Culture, Vol. 1, pp. 755-58 (1935-36).

support of the All-India Council for Technical Education. (Support now transferred to the University Grants Commission.)Teaching and research in Advanced Electronics will also be organised in certain institutions with the help of special grants made by the U.G.C. These are good beginnings. It may be confidently hoped that the younger generation will now find better opportunities for acquiring knowledge of and for research in this subject of national importance.

I may, therefore, conclude my address with an optimistic note. The hopes that I had cherished in my younger days regarding developments of research, training and industry in radio and electronics in our country are on their way to fulfillment. I now only wish that the developments proceed at a faster pace to meet the fast growing demand of trained men on the one hand, and of the various radio and electronic equipment on the other, for meeting civil, industrial and defence requirements.

SOLID STATE GAS SENSOR FOR MONITORING ENVIRONMENTAL POLLUTION

Pramod Kumar Sakharkar* and Shail Upadhyay**

Due to the enormous growth in industrial development and population, the natural atmospheric environment has become polluted. Thus, monitoring and control of such pollutants are imperative to prevent environmental disasters. Conventional analytical instrument for this purpose are time consuming, expensive, bulky and seldom used in real–time in the field. As such, a solid state gas sensor that is compact, robust with versatile applications and of low cost could be equally effective to analytical methods.

ENVIRONMENT POLLUTION : INTRODUCTION

Advancement in science and technology has produced an incredible rise in living standards, which is accompained by variety of serious environmental problems. For example of various chemical pollutants including No_x, SO_x, HCl, CO_2, volatile organic compounds (VOC_s) and flurocarbon are being released from the industries, automobiles and homes. The release of various chemical pollutants into atmosphere by various industries, automobiles and homes is causing global environmental problems (bearing well known effects) which are given in Table 1.

Table 1 : Global Environmental Problems and Related Gases

Environmental problem	Related gases
Acid Rain	NO_x, SO_x, HCL
Greenhouse Effect	CO_2, CH_4, Flurocarbon, NO_2, O_3
Ozone Layer Destruction	Flurocarbon, Halocarbon

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Environmental pollution can be classified into three categories : atmospheric or air, water and soil. Atmospheric and water pollutions cause major disaster within short period of time, since this type of pollution can diffuse rapidly over large areas and survival habits are dependant on it (i.e. for breathing and drinking water). Atmospheric pollution is defined as air containing above the regulation limits in specific regions[1], gases, offensive odors and particles that are harmful to humans, animals, vegetables or living environments.

The kind and quantities of pollution sources have also increased dramatically, hence the development of a method for monitoring and controlling these sources has become very important. The monitoring and controlling systems are needed which can rapidly and reliably detect and quantify pollution sources within the range of the regulation standard values. Until now, air pollutant measurements have been carried out with analytical instrument using optical spectroscopy or gas chromatography/mass spectrometry. However, although these instruments can give a precise analysis, they are time consuming, expensive and can seldom be used in real-time in the field. In this context, a gas sensor which is compact, robust, with versatile applications and also low cost could

be an effective alternative. Table 2 presents the comparison between gas sensor and analytical instruments.[2]

Table 2 : Comparison Between Analytical Instrument and Gas Sensor.

Parameters	Analytical instruments	Gas sensor
Resolution	Excellent	Comparable
Cost	Expensive	Fair
Size	Bulky	Compact
Rigidity	Fragile	Rigid
Process Control	Complicated	Easy
Mass production	Difficult	Easy
Measurement	Time taking	Fast

The present article gives a brief introduction about currently used types of solid state gas sensors and their comparison.

SOLID STATE GAS SENSORS

The name solid state gas sensor is used because sensing element is in solid state. The sensing element for these sensors may be deployed in the form of bulk, thick film or thin film. Advancement of gas sensor technology over the past few decades has led to significant progress in pollution control and thereby, to environmental protection. Useful reviews have been published on the solid state gas sensor.[3,4] The following three broad categories of gas to be monitored in order to prevent atmospheric pollution :

(i) Oxygen : for breathable atmospheres and control of combustion processes (boilers and internal combustion engines). In the former case, concentrations in the region of 20% and in the latter case 0–5% need to be monitored in air.

(ii) Flammable gases (CO_2, NO_2, CH_4 etc) : in order to protect against the unwanted occurence of fire or explosion. In this case concentrations to be measured are in the range up to the lower explosive limit, which for most gases, is up to a few per cent.

(iii) Toxic gaxes in air (carbon oxides, nitrogen oxides, sulphur trioxide, hydrocarbons and some other gases HCl, NO_x, SO_x, O_3, etc) : need is to monitor concentrations around the exposure limits which range from less than 1 ppm to several hundred ppm and ambient levels for environmental pollutants such as ozone which ranges up to around 100 ppb.[5]

The above-mentioned gases are mainly monitored by using three different types of solid-state gas sensors. These sensors are classified as : (i) electrolytes, (ii) catalytic and (iii) semi conducting oxides. A number of other types of solid state devices have shown promising future, but are yet to be established in real applications.

Electrochemical Sensor

As the name implies, electrochemical sensors have three components ; cathode, anode and electrolyte. When electrolyte used for the sensor is in solid state, then it is referred as solid electrolytes sensor. Solid electrolytes are those materials, which allow the conduction of ions but not the conduction of electrons. The essential function of the solid electrolyte is to separate two regions of distinct activity of the species to be monitored and to allow high mobility of an ion of that species between anode and cathode. In common with liquid electrolytes, they support the function of electrochemical cells, in which chemical reactions are only allowed to proceed to completion if separate paths are provided for the flow of ions (through the electrolyte) and electrons (through an electronic conductor). The use of solid electrolytes in chemical sensing has a considerable history stemming from the work of Nernst.[6] Based on solid electrolytes employed, Weppner have broadly classfied electrochemical sensors in three categories[7] :

Type A – Ionic species derived from the gas to be detected coincides with the mobile ion of solid electrolyte.

Type B – Ionic species derived from the gas to be detected coincides with the immobile ion of solid electrolyte.

Type C – Ionic species derived from the gas to be detected coincides with neither of mobile nor of immobile ions of solid electrolyte.

The solid electrolytes used for electrochemical sensor are mainly ceramic oxides. The ceramic oxides used as electrolytes to fabricate different electrochemical sensors for different applications have been reviewed.[8] The most successful among the electrochemical sensors are the emission control sensor (commercialy known as λ-sensor) for the automobile engine and the oxygen sensor used in steel making. Both of these sensors have stablized zirconia as electrolyte. The details about materials used for oxygen sensors, fabrication methods, designs and applications are reported in literature.[9] The schematic diagram of commonly used oxygen sensor in automible exhaust system is shown in Fig.1. Electrochemical CO_2 sensors based on NASICON solid electrolyte ($Na_3Zr_2Si_2PO_{12}$) as electrolyte are also commercially available in the market. But still research is in progress to make these sensors more practically applicable in safeguarding the environment.[10]

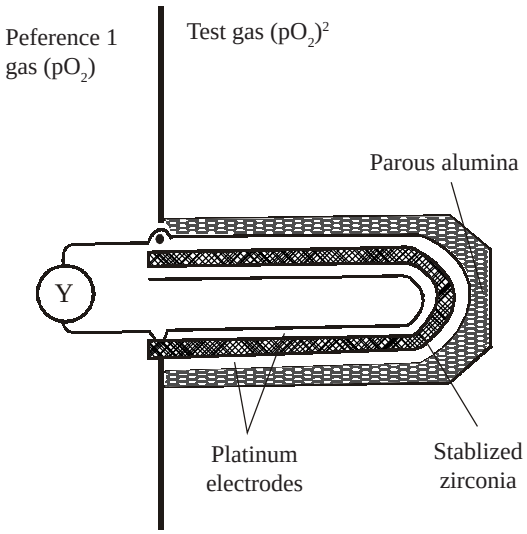

Fig. 1 : Schematic of solid electrolyte oxygen gas sensor

Catalytic Sensors

This sensor is based on the rapid combustion of flammable gases, which in turn brings a change in the temperature of resistive type sensor. The resistance of the resistive type sensor changes with change in temperature. The catalysts of the catalytic sensor catalyse the rapid combustion of the flammable gas molecules present in the air. Due to the combustion of these gases, change in the temperature takes place which is monitored by resistive type temperature element. This temperature sensor is made up of a platinum coil. The combined unit (i.e. catalysis and temperature sensor) is maintained at high temperature to ensure the completeness of combustion process rapidly. The high temperature (550ºC) is generally achieved by passing current through the platinum coil. Thus the platinum coil functions as a heater as well as resistive temperature sensor. This type of sensor is fabricated by embedding platinum coil in a refractory bead of alumina. With the advancement of technology, the temperature sensing element is spread in a fine powder within the open pores of the alumina bead (Schematic of this sensor is shown in Fig.2). Due to this the operating

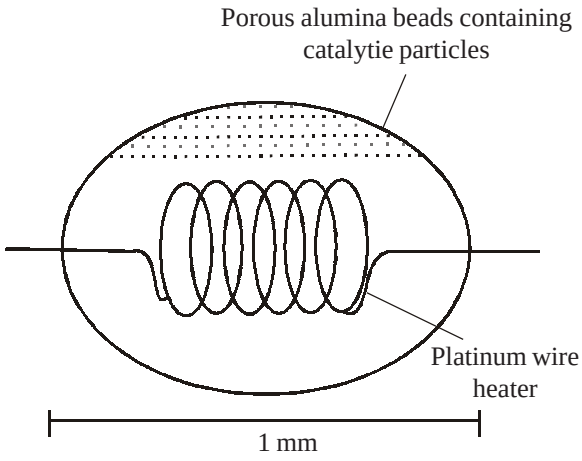

Fig. 2 : Schematic of a catalytic gas sensor

temperature of such sensors is considerably reduced as compared to earlier version which were operated at 1000ºC.

The response of such sensors depends on the product of the flammable gas concentration, heat of combustion, heat of combustion and its rate of diffusion (flow) inside the sensor. The advantage of this sensor lies in the measurement of the explosiveness of the gases present in the atmosphere in the approximate range of 0.05–5% of flammable gas volume present in air. The disadvantages of this sensor are its incapability to detect individual flammable gas (present if any in the air). If poisoning element is present in the flammable gas, the catalytic activity of the catalysis is damaged, thus shortening the life of the sensor. As a note worthy example in the case of methane, the poisoning element is halogenated hydrocarbon. Catalytic sensors are mainly used to detect methane, carbon monoxide, hydrogen and flammable gases present in the air.

Semiconducting Oxide Sensors

This sensor is based on change in the resistance or capacitance of the semiconducting oxide material on exposure to particular gas environment. When change in resistance is measured, then it is called resistive sensor and when change in capacitance is measured, then it is called capacitance sensor. Resistance type solid state sensors are mostly used for detection of gases whereas capacitance type sensors are used for monitoring relative humidity. The sensing element has a high surface to bulk ratio which is in the form of bulk, thin film or thick film. In the sensor, thin and thick film of sensing element are deposited on the insulating substrate (for example alumina and silicon) and is placed between two metal electrodes. The semiconducting materials used for the sensors are metal oxides. The metal ions on the surface of metal oxides can adsorb atmospheric oxygen very easily. These metal ions transfer their valence electrons to adsorbed oxygen atom or molecule and then the adsorbed (adsorption is the process by which one substance is taken by another substance, either chemically or physically) oxygen becomes chemisorbed oxygen ion O^- or O^{2-}. The interaction of sensing material with reducing gas (CO, NO, SO, etc) takes place according to:

$$R + O^-_{(ads.)} \rightarrow RO + e^-$$

where R refers to reducing gas. The electrons released in the above process increase of decrease the resistance of the semiconductor oxides. The increase or decrease in the resistance value on the absorption of gas at the surface of semiconducting oxide depends on the nature of majority charge carriers and monitoring gas. The change in the resistance of the semiconductor materials on adsorption of reducing and oxidizing gas is present in the Table 3.

Table 3 : **Resistance response expected for reducing and oxidizing gases on n-type and p-rype semi conducting oxides.**

Semiconductor material	Reducing gases	Oxidizing gases
n-type	Resistance falls	Resistance rises
p-type	Resistance rises	Resistance falls

The configuration of a simple semiconductor gas sensor using metal oxides is shown in **Fig. 3**.

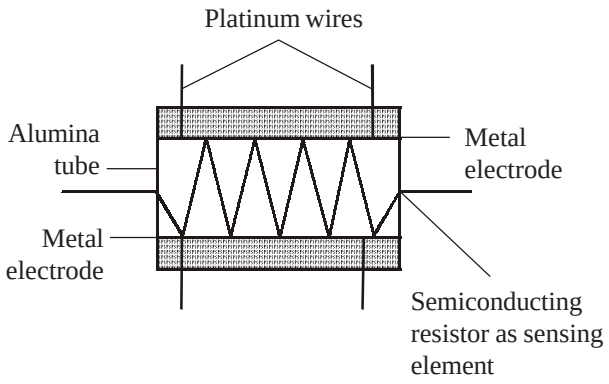

Fig. 3 : Schematic of a resistive semiconductor gas sensor

In contrast to other semiconductors that undergo irreversible chemical reactions forming stable oxides upon exposure to air at high temperature, metal oxides remain stable while interacting with oxygen at their surfaces.

The first semiconductor oxide gas sensors were reported by Seiyama *et al*. in 1962. Since then, there have been numerous studies concerning such oxide semiconductors as SnO_2, ZnO_2, In_2O_3, TiO_2, Fe_2O_3, HfO_2, and $BaSnO_3$. They are nowadays widely used in the detection of gases. At present most of the commercially applied resistance sensors are based upon SnO_2 and Fe_2O_3 bulk material. They are fabricated by companies like Figaro Inc. and Matsushita Electric Industrial Ltd., with a production output in the order of 10^6 sensors per year. Semiconductor oxide gas sensors are extensively studied in order to improve their sensing characteristics, i.e., sensitivity, selectivity, stability, and response rate, to various kinds of gases and to meet the increasing needs of sensors in complicated systems and under strict conditions. A trial-and-error method is still mainly used in the development of new sensor materials to replace existing sensor materials.

With the advent of automatic control applications, the need for miniaturized, intelligent and programmable sensors has become an important issue. To achieve these goals, the exploitation of thin-film sensors on silicon substrates has become the target of investigations. Perovskite-type oxides (ABO_3) have attracted much attention in recent years because the sensing and electronic properties of these oxides may be modified by an appropriate combination of cationic substitution. The current research is focused on development of Perovskite oxide based gas and multifunctional sensors. (to sense gas, temperature, humidity, light etc using one sensor).

CONCLUSIONS

The article presented an overview of atmospheric pollution and emitting sources. A brief introduction of solid state sensor is also presented. The resent increase in living standard of human being have increased monitoring pollutant gases which resulted in rapid development of solid state gas sensors The sensing mechanism of electrolytic, catalytic and semiconductor solid state sensors is described. A comparison of these sensors is presented in Table 4.

Table 4 : Comparison of sensing characteristics of various types of chemical sensors.

Parameters	Semicon-ductor	Catalytic	Solid Electrolytic	Infra red adsorption
Sensitivity	●	O	●	●
Accuracy	O	●	O	●
Selectivity	Δ	x	–	●
Response	●	O	●	O
Stability	●	O	O	O
Maintenance	●	O	●	Δ
Cost	●	●	O	Δ
Detectable Concentration	Few ppm	10 ppm	10^{-11}–1 atm.1	ppm–100%

● –Excellent ; O – Good ; Δ – Poor ; X - Bad

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DO YOU KNOW ?

Q1. Which sport is a taxophilite enthusiast of ?

Q2. Is there any railway station that has all three gauges ?

Q3. Who is a Lepidapterist ?

AND QUIET FLOWS THE RIVER KELVIN : LOOKING BACK TO AN 'ABSOLUTE' LORD WHO TURNED NATURAL PHILOSOPHY INTO PHYSICS

Bhupati Chakrabarti*

Lord Kelvin, who was born William Thomson, was an extraordinary scientist of nineteenth century. His contribution in the fields of science and technology was stupendous but, at the same time, he could not foresee a number of developments in the horizons of physics when he was in an advanced age and the world of physics was changing around him. His long active life is presented here briefly.

INTRODUCTION

"Two of the base units in Sl bear the names of the two scientists, fittingly one of them is a French and the other hail from the British lsles. Among them, Andre Marie Ampere was the senior one from France who actually gave his well-known swimming rule to make a very candid statement of the magnetic effect of electric current around the year William Thomson was born. The base unit of temperature is named after him when he was bestowed with the title of Lord Kelvin, a name taken from a small river that flows through Thomson's native place in Scotland. However the present story is about Lord Kelvin whose contribution of physics of nineteenth century can only be compared to the work of Michael Faraday, in experiments and with James Clerk Maxwell in theory. Kelvin was one of the rare physicists to handle both theory and experiment with equal aplomb. Here we shall try to take a look at the life and work of this Victorian stalwart.

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Lord Kelvin : A brief life sketch

Lord Kelivn was born as William Thomson in 1824 in Belfast, Scotland. His father was a teacher in Belfast and later became a Professor of Mathematics in the University of Glasgow when William was about nine years old. William and his brothers and sisters were exposed to a cosmopolitan life and were sent to France for the study of language and to know about the contributions of the French scientist and mathematicians. It was in the 1830s and people at the British lsles has such a strong influence of Newton that they were not much interested in the works of the continental scientists. The subtle rivalry with the French was part of the British psyche. But William Thomson was attracted towards the work of three L's of France, viz. Lagrange, Legendre and Laplace. William also traveled to Netherlands as a teenager and that possibly helped him to develop a positive worldview about science. Developing an overview at that time was typical of British society as it had colonies on different parts of the world and the people from the British lsles used to move a lot all over the world.

Interestingly, Thomson was appointed a Professor of Natural Philosophy in Glasgow

University in 1846 only at the age of 22 and spent the rest of his working life in that position but gave shape to a subject that came to be known as physics. In fact he was in that Chair for next fifty-three years. His book, co-authored with Sir James Tait was published in 1867, was an authoritative one for the physicists for years, but the title of the book was 'Treatise on Natural Philosophy'. This possibly indicates how a subject still considered to a be a part of natural philosophy transformed into a rigorous science with the methods well defined from the inputs of nineteenth century stalwarts that includes Lord Kelvin. And Lord Kelvin, we know was a physicist and not a 'natural philosopher'.

Kelvin actually turned into Lord only in 1893 when he was nearly seventy years old. As William Thomson he collaborated with number of scientists cutting across the nationality. His collaborators include Hermann von Helmholtz, who was a German while others like Joseph Tait and Sir George Gabriel Stokes and James Joule were the British scientists. On the other hand, he had serious difference of opinion with his native Charles Drawin of the geological age of earth, hence with the theory of evolution. Thomson's orientation to physics was so strong that he believed that all laws should be deducible analytically and the theory of evolution did not fit into that structure. He calculated how old the earth is from his concepts of electromagnetism. But this led to a serious disagreement with Charles Darwin who was about fifteen years senior to him. Thomson was wrong in this case but he could develop a principle for the determination of the age of earth '—' the biological and geological estimations should be consistent with the principles of physics. And Thomson was always forthright in expressing his views on different issues. He virtually worked all along his life and the last few of about the 70 patents, that he took in his life, actually were granted to him between 1904 and 1907 i.e when he was more than 80 years old. In fact, some of these patents were granted even on the year he passed away.

HIS SCIENTIFIC WORK

Like a number of nineteenth century scientists and mathematicians, Thomson also ventured in the fields considered quite diverse today. He first met James Prescott Joule in 1847 in a scientific meeting and started interacting with him. He again met Joule in Switzerland after a brief gap and did carry out some work with him on the nature of heat. These interactions formed the background that prompted William Thomson to propose a temperature scale that is independent of the nature of the working substance. He was then only 24 years old. In the year 1851, when he was just twenty-seven years old, he presented a paper in the meeting of Royal Society of Edinburgh. and in this paper he talked about the dynamic nature of heat and the principle of conservation of heat and gave shape to what is today known as second law of thermodynamics. Interestingly this statement of the second law is known by the name of Kelvin but the formalization of the statement was made at a time when he was known as William Thomson and not as Lord Kelvin. Large number of contributions in physics go by both the names of Kelvin and William Thomson and students of physics cannot always keep this in mind that these two names represent the same personality.

Normally people take cognizance of a scientist through his work that has actually influenced their lives. That way Kelvin's work related to transatlantic wire was unique. That actually fetched him a knighthood in the year 1866. However he is one of the very few scientists whose name we come across when we learn about the units in physical science. Thomson loved sea and voyages. He was responsible for several maritime innovations that were considered to be very important at that time. He perfected the adjustable compass, necessary at a time when ships were constructed with lot of iron, developed a covenient method for measuring the depth of the sea and invented a machine to predict the tides.

If we look back at his contribution in the field of physics, one will find a significant number of techniques used in the measurements of different physical quantities in physics and a bunch of principles bear his name. All these were devised or suggested by either William Thomson or Lord Kelvin or by his collaborators, The Kelvin double bridge for the measurement of small current, Joule-Thomson effect, Kelvin balance, Thomson effect in thermoelectricity, Kelvin scale of temperature are just a few to mention. He was also instrumental in designing the Niagara Falls power station. In fact, Thomson started writing research papers in his teens and wrote about 660 papers in his whole life ; an astounding figure by all standards!

WILLIAM THOMSON : A BRILLIANT MAN AND AN INTERESTING CHARACTER

The very colourful character known as Lord Kelvin has made him a public figure and he made a lot of comments on science and mathematics and technology as well with a lot of conviction. In fact, some of his predictions or comments have been proved to be quite misjudged, but he was always very candid in making his views clear. In 1896, he observed 'Physics has not much of the things left to be discovered. We can at best make refinment of our measurements' and we know how wrong he was. He also proved wrong while he said 'Flying machine heavier than air are impossible' at a time when lots of people including the Wright Brothers were trying to build up what is today known as aeroplanes and were referred to as flying machines during those days. The same scientist could make a comment that essentially describes the nature of physics by saying 'if you can measure something and put that in numbers you know something about that'. The fact that in physics one will have to quantify the observations and the qualitative statements will not help us to unravel the mysteries on the physical world, was very much in his mind. He had a very dynamic mind that can be concluded from the following incident that took place early in his career. Prof J. V. Narlikar has written about this incident in his book entitled 'One hundred Reasons to be a Scientist' published by the Abdus Salaam International Centre of Theoretical Physics.

It is well known that one gentleman called S. Parkinson became the Wrangler in Cambridge appearing in the very prestigious examination called Mathematical Tripos in the same year when Thomson also appeared for the same examination. In fact, Thomson got the second position, usually known as 'Second Wrangler' after Parkinson. In this examination, one paper-setter cum examiner, a university professor found that only two students have given satisfactory answer to a problem that was not from any standard book but from a research paper that the professor consulted. In fact, he also found that the first two position holders have done so and their answers look quite similar. So he thought that he will call both of them up to see whether there was any malpractice or not.

First came Parkinson. On the query of the professor he said that he was in the habit of going through research papers in the journals and saw the problem in a journal. In fact, he could actually quote the name of the journal which satisfied the examiner immensely. Then the professor called Thomson and told him, possibly a bit sternly, how he could answer the question and added that he is not ready to accept that Thomson also consulted the journal from where he set this question. And Thomson did oblige his examiner. He said calmly "Sir, I did not consult the research paper but authored it." However, the examiner professor could not make it out as it was possibly Thomson's paper on Fourier's work and was written under the pseudonym P.Q.R.

Interestingly Thomson himself was very confident of getting the first position designated as 'Senior Wrangler' and was just interested to know who stood second. He sent his servant alone to the University to bring this information. But the servant came back and told him that he was the second Wrangler as he secured the second position. That possibly upset him because it was oberved that his confidence was bordering with some sort of pride that was not very uncommon among the Victorian stalwarts in different fields. Some of the Kelvin's sweeping comments testified these.

S. Parkinson was definitely a very good student and he actually held very high position in Cambridge. But he was possibly very proficient in mastering what was there in the textbooks and journals. And Thomson had the imagination. He could always think something new, possibly the problems from as variant fields as of physics, mathematics, geology, telecommunication, and even others looking for solutions could draw his attention and imagination. Like other pioneers in scientific research, he could think anew and could come up with novel ideas that is the hallmark of a stalwart.

THOMSON SHOT INTO FAME

Thomson was shot into fame when he undertook the responsibility of solving a problem of transatlantic telephone cable laying. At that time, this proved to be quite tough task and engineers and technicians were failing again and again in this work. Thomson studied the whole thing, suggested a solution, boarded the cable laying ship and actually reached USA on the other side of Atlantic with the telephone cable intact. Thomson personally oversaw the successful laying of the first transatlantic cable in 1866. This cable was meant for sending messages between Europe and the USA using technology Thomson himself had invented. On the tenth of November of that year, Thomson received a knighthood in honour of his achievement. This cable laying brought America closer to the rest of the world. He could actually calculate the mid ocean currents and their roles in snapping the cable. In fact, during his lifetime, this great physicist was better known as an engineer for his feat in laying of the telephone cable.

This feat made him immensely popular on the other side of the Atlantic as well. The University of Glasgow had a great celebration in 1896 when Thomson completed fifty years in that post. Nearly 2500 people attended the ceremony including the guests from the other side of the Atlantic. Considering the fact that it was the days before the air travel came into being, one must appreciate the wide range of respect and popularity that Thomson used to enjoy inthe scientific community.

FINAL YEARS

Lord Kelvin equally proficient in theoretical and experimental physics, had a strong faith on the most crucial aspect of physics, viz. quantification through measurements. He always used to advocate the act of measurement. He was created Baron Kelvin of Largs in 1892 (a title that died with him, as he left no heirs) in honour of the river that flows past Glasgow University, and was elevated to the Privy Council in 1902. Before that he was the President of Royal Society of London from 1890 to 1895.

In 1900 he said "There is nothing new to be discovered in physics now. All that remains is more and more precise measurement." He passed away in December, 1907 with some sort of conviction that there will only be finer improvement of the physical constants through precision measurements and since 'not much was left to be discovered'. Now we know how a scientist of Kelvin stature can also make big mistakes. It was

at the time of his passing away the world of physics, where Kelvin contributed a lot, was getting prepared to enter a new era some of which were based on Kelvin's own contribution. Einstein and Planck had already contributed epoch making ideas, Rutherford was working hard to get into the inside of the atom and the birth of quantum mechanics was round the corner. This however does not take away any credit that is rightly due for Lord Kelvin. It only shows science moves on with the newer discoveries and what is correct today may prove entirely wrong tomorrow. He was buried in Westminster Abbey, alongside lsaac Newton.

SUGGESTIONS FOR FURTHER READING :

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DO YOU KNOW ?

Q4. Where does the word Alphabet come from ?

Q5. One can climb a high tower using a straight flight of stairs or a spiral staircase, which goes around the tower. In which case does one spend more energy to scale the height ?

Q6. In central America, a particular creature is found so much in abundance that every year some 20 new species are discovered. What is it ?

PRODUCTION OF CLONED ANIMALS USING SOMATIC CELLS AND THEIR APPLICATIONS

Yogesh S. Akshey, Arun Kumar De and Dhruba Malakar*

Somatic cell nuclear transfer (SCNT) can be used for production of desrirable infinite number of identical individual, transgenesis, embryonic stem cells, xenotransplantation, endanger and extinct animals. SCNT has been described beneficial to animal, agriculture and human medicine to treat the incurable disease like Parkinson, Alzheimer, Heart attack and Diabetes. It has become an essential tool for studying gene function, genomic imprinting, genomic re-programming, regulation of development, genetic diseases, and gene therapy, as well as many other topics. Hand made cloning is very simple, easy to perform, less expensive and high cloning efficiency than micromanipulator based techniques.

INTRODUCTION

Cloning is the creation of an exact genetic replica of a small segment of DNA, a cell or a whole organism. Cloning is derived from the Greek word "klon" which means a twing, which can replicate itself and grows eventually into a tree. To clone is to reproduce asexually or to make a copy or set of copies of an organism following the fission or insertion of a diploid nucleus into an oocyte.

"A true clone is an individual, which has all the components that make up the individual including nuclear genetic material (genome) and other maternally derived factors". In the laboratory, cloning in mammals involves replacing the genetic material of an egg with the genetic material of a somatic cell from an embryo of adult which will eventually develop into a full organism.

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One great advantage of cloning from somatic cells is that specific types of somatic cells are easily propagated in culture for many million of cells that can be used either to produce large numbers of identical offspring or for genetic modification of cells. The second advantage is that somatic cell can be recovered from adult animals and being successfully used to make genetically identical copies of existing animals[1].

Somatic cell nuclear transfer is a technique in which the nucleus of a somatic cell is transferred into enucleated metaphase-II oocytes for the generation of a new individual, which are genetically identical to the somatic cell donor. "Dolly" is the first successful cloned sheep obtained from a differentiated adult mammary epithelial cell which has created a revolution in science[2]. Subse-quently, first cloned cattle[3], cloned goat and many other species were also produced by SCNT.

DIFFERENT KINDS OF CLONING

Cloning in Nature

Cloning as an asexual reproduction is a very common form of multiplication in plants. In all plant organs, stems are most common source of asexual reproduction. In animals, the reproductive process is diversified. The various forms of asexual reproduction coexist with hermaphroditism and bisexual external and internal copulation. Asexual reproduction includes budding (jellyfish, corals and tapeworms), fragmentation (worm), and partheno-genesis (some fishes, insects, frogs and lizards).

Embryo Splitting

Different stages of embryos from cleaved to moruale, which can be used for production of genetically identical twins. Upto the morula stage embryo is not differentiated and it posseses totipotency to produce entire individual with placental tissue. Once the embryo becomes differentiated into blastocyst, it becomes pluripotent which produces individual without placenta which act as a barrier between mother and fetus tissue. So, this blastocyst cannot be used for production of clone. Identical individual can also be produced by embryo splitting with sharp blade. This technique is generally called "embryo splitting".

Embryonic Cell or Blastomere Cloning

In this technique, blastomeres, which can be obtained from preimplanted embryos that is from cleaved embryo to blastocyst stage embryos. These embryos contain number of stem cells, which are totipotent, or pluripotent in nature. This is one way to produce the clone individuals by using embryonic cell, all individuals contain same genetic make. Embryonic cells are by using these cells the probability of production of clone animals is increased many fold as compared to adult somatic cells.

Somatic Cell Nuclear Transfer

The birth of Dolly, the first successful cloned sheep created a revolution in field of science[2]. Somatic cell nuclear transfer is a technique in which the nucleus of a somatic cell is transferred into enucleated metaphase-II oocytes for the generation of a new individual, which is genetically identical to the somatic cell donor. Cloning a growing adult animal is achieved by removing the nucleus of a somatic cell and inserting it into an enucleated egg[1, 2]. Subsequently first cloned cattle[3], cloned goat and nine other species were also produced by this tecnuique.

PURPOSE OF SOMATIC CELL CLONING

Therapeutic Cloning

Therapeutic cloning is the production of cloned cells to produce tissues and/or organs, mainly to improve healthcare treatments. SCNT requires for production of an embryo, the cells produced are completely totipotent ; they are able to produce a complete individual and that is the basis of reproductive cloning. As the embryo develops blastocyst, it is possible to collect only the inner cell mass cells from the blastocyst and produce embryonic stem cells.

For therapeutic cloning, also called somatic cell nuclear transfer (SCNT), the DNA from any one cell in the body of patient could be removed and inserted into an unfertilized egg that previously had its own DNA removed. In a culture dish, the egg is then coaxed into developing as if it had been fertilized. The one egg cell divides rapidly to produce blastocyst in 5-6 days. The inner cell mass of the blastocyst is then removed and embryonic stem cells grown. These embryonic stem cells, containing the patient's DNA, now match the patient's immunological profile and will not be rejected by the patient's immune system. These

embryonic stem cells can now be used to generate cells and tissues for the patient.

Reproductive Cloning

To produce a group of individuals with identical genetic makeup from single common parent is derived by SCNT. This approach is important in animal farming as well as in the pursuit to clone endangered and extinct animals. Donor nucleus is placed inside the enucleated oocytes and electrofused and activated. Reconstituted zygote is formed, equivalent to a fertilized ovum with potential to develop into blastocyst. It is implanted and developed into offspring. Hence, clone is an identical individual of donor animal.

APPLIED TECHNIQUES OF SCNT

Micromanipulator Base Method

Traditional somatic cell nuclear transfer carried out by using different expensive equipments like micromanipulation system, and there accessories. The traditional cloning method is based on oocyte enucleation procedure using micromanipulator. There are various factors present in oocyte cytoplasm, which reprogram the donor cell nucleus after nuclear transfer. The volume of cytoplasm of an oocyte is affected by micromanipulation and it decreases up to 39-50% of total cell volume of cytoplasm of an oocyte. This will affect proper nuclear reprogramming of donor cell nuclei. It also affects the pregnancy rate due to improper placentation and various anomalies in cloned offspring generally called as Cloning Syndrome[4].

Hand Made Cloning (HMC) Method

This method is modified for optimization of cloning efficiency by utilizing limited resources, manpower and time. This is a new technique called hand made cloning technique which maintains the cytoplasmic volume up to 100%. The difference is that enucleation procedure and fusion of enucleated oocyte are carried out after zona removal and enucleation of oocyte by bisection and culture for reconstructed embryos[5]. The high cloning efficiency in addition to the low cost of equipment makes this technology very economical and affordable. Presently, few reports are available in such type of cloning procedure in cattle[6], horse[7], and pig[5].

HMC techniques have resulted in birth of approximately 20-25 healthy calves in Australia, New Zealand and South Africa, and ongoing experiments are now at an advanced stage. In the case of goat no such cloning abnormalities were found[8] even in IVF goat[9] and Hand Made Cloning technique[5, 10] of other animals also.

SOMATIC CELL NUCLEAR TRANSFER :

Applications

A number of applications of SCNT have been described as beneficial to animal, agriculture and human medicine. Reproductive cloning can be used for production of genetically superior animals, disease resistant animals and high quality meat and dairy products. Cloning can ensure the creation of more number of desired male/female offspring. There is also increasing interest so utilize SCNT to restore endangered or even extinct species[11].

Cloning in Farm Animal Production

Nuclear transfer can in principle be used to create an infinite number of clones of the best farm animals. Cloned elite cows have already been sold at auction for over $40,000 each in the USA but these prices reflect their novelty value rather than their economic worth. To be effective, cloning would have to be integrated systematically into breeding programmes and care would be needed to preserve genetic diversity.

Production of Human Proteins for Therapy

Human proteins are in great demand for the treatment of a variety of diseases. Human proteins can be produced in the milk through SCNT of transgenic sheep, goats and cattle. Nuclear transfer allows human genes to be inserted at specific points in the genome, improving the reliability of their expression and allows genes to be deleted or substituted as well as added. Output can be as high as 40 g per litter of milk and costs are relatively low.

Xenotransplanation

The chronic shortage of organs means that only a fraction of patients who could be benefited actually receive transplants. Genetically modified pigs are being developed as an alternative source of organs by a number of companies. Nuclear transfer will allow genes to be deleted from pigs and much attention is being directed to eliminating the alpha-galactosyltransferase gene. This codes for an enzyme that creates carbohydrate groups which are attached to pig tissues and which would be largely responsible for the immediate rejection of an organ from a normal pig by a human patient.

Cell Based Therapies

Cell transplants are being developed for a wide variety of common diseases, including Parkinson's disease, heart attack, stroke and diabetes. Transplanted cells are as likely to be rejected as organs but this problem could be avoided if the type of cells needed could be derived from the patients themselves. The implications of such clinical applications include the ability to treat and overcome aging, disease, cancer, myocardial infarctions, renal failure, liver failure, and genetic disorders. These cells will form the basis of new therapies in the battle against death and disease—cell-based therapies will be the next major approach in medicine. The final step is to develop the organ completely ex-vivo, probably in conjunction with xenotransplantation, before transplant. Scientists demonstrated that one could use SCNT for generation of histocompatible tissue addressing one of the major challenges in transplantation medicine. Somatic cell cloning may also be used to produce transgenic animals for pharmaceutical protein production or xeno-transplanation and allotransplantation. In addition to its practical applications, cloning has become an essential tool for studying gene function, genomic imprinting, genomic reprogramming, regulation of development, genetic diseases, and gene therapy, as well as many other topics.

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ASSISTIVE TECHNOLOGY FOR THE VISUALLY IMPAIRED

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Computer technology, with specialized hardware and software, has changed the lives of countless individuals with visual impairments. Assistive or adaptive technology has overcome many barriers to education and employment for low or poor vision individuals. Websites are being optimally designed for use by web surfers with visual impairments.

INTRODUCTION

Technology has touched every aspect of our life. Each advancement marks a step in the betterment of its quality. Technology has transformed the educational system in such a way that it has not only revolutionized the educational scenario but has also given tremendous benefits to people who are visually impaired. The world of printed information in the form of books, newspapers, magazines and websites was beyond people with little or no sight. The advancement in computer technology has now brought this world within their reach. All such technological devices are termed "assistive technology devices" which could be any item, piece of equipment, or product system, whether acquired commercially or off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities[1]. These may be of use to people suffering from all sorts of vision related problems like poor acuity, near or farsightedness, extreme sensitivity to light and/or glare, color distortions, visual field defects, spots before the eyes, and also central vision loss.

Assistive Devices or devices of assistive technology that are available today can be categorized into[2] :

- Large print access
- Speech access
- Braille access
- Scanned material access

Large Print Access

These include hardware and software that can provide enlarged letters or fonts to persons with partial sight. For instance, the 'screen magnification software' which magnifies the information on the screen by a pre-determined incremental factor (2x magnification, 3x magnification, etc) fall under this category. Running simultaneously with a computer's operating system and applications, most screen magnification software have the flexibility to magnify the full screen, parts of the screen or provide a magnifying glass view of the area around the curser or pointer. Many a times the CCTV and magnification scanning system are used in an integrated fashion to obtain enlarged images of the material under the camera. This device includes a video camera with zoom lens, monitor or television screen and several options for switching polarity, focusing and viewing table for easy material movement. Certain portable hand-held devices are also being manufactured and marketed.

Speech Access

Some people have usable vision, allowing them to read large print. Others choose to read braille on

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paper, while some prefer to use a computer with synthetic speech. 'Screen readers' are software programs that work in conjunction with a speech synthesizer to provide verbalization of everything on screen including menus, punctuation marks and the entire text. 'JAWS or JOB Access With Speech' is the most popular screen reader. It supports web browers for internet access, email programs, word processors, presentation software, spread sheets and much more. Other speech access devices like the talking word processors are also becoming increasingly popular. One such program 'Intellitalk' allows the student to hear the letter, word, sentence or phrase as it is entered into the computer. These programs work in both windows as well as DOS environments.

Braille Access

For persons who have learnt Braille and are comfortable using it, speech access through screen readers may not be the most convenient option. Besides, every one may not like personal information to be read out aloud and would prefer using devices providing Braille access. In order to produce Braille material, a translation and formatting program needs to be used in conjunction with hardware devices like the Braille embosser (Braille printer). Such programs are used in systems attached to Braille embossers that produce Braille output on special paper instead of the print output. Another useful assistive device in the Braille refreshable display. This enables the Braille reader to read line by line in Braille through refreshable braille cells (the tactile display of dots can be changed after being read or at will by the user), which can be scrolled, navigated and also displayed in normal text form on a LCD screen for a normally sighted partner or assistant. ALVA, Braille Window, Power Braille, etc are some examples of such devices.

Sometimes portability of the system becomes an issue. People used to these devices feel uncomfortable when they are outdoors or when these devices are not available at hand. In order to meet such inconveniences, portable devices also called PDA's or Personal Data Assistants are used. Some of these are 'Braille'n Speak' which have Braille keyboard layout and speech output, 'Braille Lite' and 'Braille Companion' which have a Braille keboard, speech output and refreshable Braille. These devices enable a person to write, review and edit data. They can keep a virtual address book, text pages, notes, etc. Some devices provide the additional facility of multiple languages so that the person using the device may switch between two different languages at the touch of a key. These can also be used as the speech synthesizer for creating output in Braille or print. When connected to the internet, they can go on-line, send and receive e-mail, and surf the Internet.

Scanned Material Access

Reading material that is not available in Braille form or in the digital form can be made available to persons using scanners attached to screen readers or speech synthesizers. Such devices go a long way in enhancing the accessibility of persons with visual impairment. Some of these devices can even be used for graphics or pictures, that is material not in the text form. The 'Open Book' is one such device that uses a scanner to take a picture of the page, sends it to the computer which translates the picture into understandable text, and then reads the text aloud or outputs to Braille. The time for the whole process may not be more than a minute. The added advantage is the multilingual output. Such devices give flexible, easy scanning even if the page is not placed right, that is sideways or upside down. Another useful device is the VERA i.e. 'Very Easy Reading Appliance'. This is a tool for persons who have partial sightedness or low vision. This is an easy to use reading tool that magnifies the text on the optional display screen, or reads text aloud. It has a key board with large keys and colorful tactile markings for easy, intuitive use. Each key serves only one function. The screen display has the facility of text magnification and changing text and background colors.

The 'Kurzweil 1000 software' converts the printed word into speech and has the ability to find key words or phrases within a document, editing of scanned text, magnification of scanned documents to accommodate users with visual impairments, and the ability to specify unlimited bookmarks within a document. Other unique features include : a 175,000 word talking dictionary ; the ability to insert a scanned page within a document, and the added convenience of background scanning which allows users to scan while working within another application. Additional features include an accurate optical character recognition (OCR), synthetic speech and the ability to decipher multi-column text.

ACCESSING THE INTERNET

The problems faced by a person with visual impairment are numerous and a lot of them are partially resolved through assistive devices. Accessing print material is only one such issue. The recent popularization of the Internet has raised issues related to the accessibility of websites. The World Wide Web (WWW) is an easy-to-use, point and click document retrieval system, which majority of the people use today. The fact that the vast majority of the information on the Internet now occurs primarily in the form text-based Web documents, makes Internet a valuable resource for all users, particularly those with disabilities.[3] Certain simple sensitive measures, particularly in web designing, can go a long way in making the internet accessible for persons with special needs.

The main problem arises when websites have web pages with excessive graphics, as screen readers find it difficult to decipher graphic images. Placing a general outline, which would contain textual description of the image or diagram at the point on the page where a screen reader would begin to read should help. This need not change the appearance of a web document since this information can be displayed as Alternate (ALT), an attribute used with the 'image' tag in XHTML and HTML codes. Using too many columns on the web page is another hindrance in accessibility and should be avoided. Ordered lists with numbers must be preferred to unordered lists as the numbers are easy to remember, a facility the user may use for back tracking or reviewing. Lists within lists must be avoided as they tend to be read as a single list thereby causing confusion to the user. Links to other pages and sites must be created with appropriate alternate descriptions. The links must be large in area and recognizable on simple mouse hover. Preferably, an outline of the linked page should be available when the screen reader reaches the link.

Uncommon typographical characters or constructions should be omitted. It should be remembered that screen readers read every word, so an effort to keep things simple is called for. Irrelevant information, such as descriptions of page borders and decorative graphics must be avoided. Simple layouts make it less time consuming to navigate a document. Efficiency increases if text only alternatives to more image intensive pages are offered. For blind users, loading images is simply a waste of time, because they do not enhance their exploration of a site. For people who are partially sighted provision for increased font size or versions of the site with varying font sizes must be available.

INDIGENOUS ASSISTIVE DEVICES

In India the population of persons with vision related disability is substantially large. Unfortunately many institutions and persons cannot afford such expensive electronic devices. The '*Pragnya*[4] Sketching Device' is an indigenous assistive device developed by volunteers of Blind People's Association. It is an innovative sketching device that enables a visually impaired child as well as a low vision child to create simple sketches and diagrams out of a thread. It uses acrylic thread as "writing ink" and nylon fabric fastener strips as a "writing slate". Acrylic thread of a contrast colour working as refill is passed through the empty body

of an open ended ball pen, keeping the other end attached to bobbin spool on which it is wound. The nylon fastener strips are stitched together width wise and pasted on the wooden board to make 1′×1′ area. The child holds the pen as any other normal pen for a sighted person and makes contact of the thread over the slate surface. Keeping continuous touch with the surface, the child glides the pen in different directions and the thread delivery is maintained smoothly through the rotating spool. A line can be terminated by snapping off the thread by using a sharp stationary blade. A continuous running thread can also make different shapes like circles, rectangles, curved lines, letters, graphic symbols, maps, etc. The drawn picture can be easily "erased" by simply pulling away the thread from the slate surface and rewinding it again over the spool. The child can immediately feel the shape by moving fingers over the thread surface and add, correct or erase the line quickly. It enables interaction of the child with the writing media and encourages drawing of various objects. A low vision child may see the shapes by holding the board close to eyes. The device has many advantages in addition to being self-operated, user friendly, cheap, affordable and easy to manufacture device that serves as useful educational media for the teaching personnel. It operates on concept of "draw as you think" which is better as compared to tactile devices where "embossing" is carried out on the reverse side of the paper, metal sheet, etc. to get mirror image of the actual profile.

CONCLUSION :

An important fact to be considered is that not all sight impaired people suffer from a total loss of vision. There are various eye disorders, such as colour blindness, tunnel vision and, inability to focus. Cataract is a common vision related problem arising with age. Each of these conditions impedes the processing of visual information in a different way. It has been seen that when low vision persons do not use their residual sight, it worsens with time. If however, they continue to make use of this sight, there are good chances of improvement. Treating all persons as blind and relying totally on Braille and tactile devices is not a good practice and must be avoided. Besides, each person has his/her own preferences, while some may be more comfortable using screen readers others may prefer Braille output. Therefore, instead of imposing one device on all, individuals must be given ample choice to pick from. In addition, thought should be given to the size and colour of text and images, the level of colour contrast, and the design of the document's background whether it is printed material to be screened or in a digital form to be read by screen reader software. Ultimately, it is the sensitivity of each person that makes the real difference.

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SWINE FLU FACTS : NEW INFLUENZA A (H1N1)

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This is a write-up summing up the currently known facts about the new Influenza A (H1N1) virus.

INTRODUCTION

Runny nose ? Wheezy breathing? Sneezing loudly ? Oh! It is just the flu. Influenza, or flu as it is commonly known, has been part of the seasonal sicknesses that affect us. Everybody had had a bout of flu sometime or the other. Usually it is nothing that a bit of rest and plenty of fluids do not cure. But this is no reason to take the flue lightly. It can, and sometimes does, turn into a killer. The most severe global outbreak of influenza occurred in 1918-1919. It caused an extimated 40 to 50 million deaths worldwide. Epidemiological models project that a similar global outbreak today could result in 2-to 7.4 million deaths globally.

But come to think of it "flu" isn't just flu any more. It has specific names. For example, there is Bird flu (or Avian H5N1 Influenza as the World Health Organization or WHO calls it) or Swine flu (new Influenza A (H1N1), in WHO terminology). There is something different...ominously different...about these "influenzas."

PANDEMIC PANIC

On 11 June Dr Margaret Chan, Director-General of the World Health Organization (WHO) announced the decision of WHO to raise the level of Influenza Pandemic Alert from phase 5 to phase 6. It was an announcement that heralded the start of the 2009 influenza pandemic. A disease assumes epidemic proportions when there are more cases of the disease than is considered normal. A pandemic is a ***worldwide epidemic*** of a disease. A pandemic may occur when a new virus appears against which the human population has no immunity. Pandemics can be either mild or severe and its severity can change as it runs its course. On 15 July 2009, WHO website reflects that "At this time, WHO considers the overall severity of the influenza pandemic to be moderate."

If a pandemic occurs it is correct to assume that the virus will spread rapidly. The most important warning signal comes when clusters of patients with clinical symptoms of influenza, closely related in time and place, are detected, as this suggests human-to-human transmission is taking place. The fact that infected poeple can shed virus before symptoms appear, compounds the risk of international spread via asymptomatic air travelers. And this is the fear that has prompted pro-active medical-vigilance at airports, although as of now, WHO has not advised restriction on regular travel or closure of borders. Urbanization and overcrowded conditions are also key factors that speed up viral transmission.

UNDERSTANDING THE INFLUENZA VIRUS

- Influenza viruses are grouped into three types: A, B and C.

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- Only influenza A viruses can cause pandemics.
- Influenza virus A clssification is based on variations on two proteins found on the virus surface. These are Hemagglutinin and Neuraminidase.
- Hemagglutinin, abbreviated H, has 16 subtypes, and Neuraminidase abbreviated N, has nine subtypes.
- Theoretically, that means 144 subtypes are possible, although not all have actually been observed.
- Influenza A subtypes are further divided into strains that are named after the location and year of the outbreaks.
- The virus behind the current pandemic is being described as a new subtype of A/H1N1 not previously detected in swine or humans.
- A person who is immune to a specific strain, either through vaccination or after being infected with it once, is not necessarily immune to other strains of the same subtypes.

Spread of Influenza A (H1N1) virus

WHO has a network of more than 120 National Influenza Centres in over 90 countries that monitor influenza activity and isolate influenza viruses in every region of the world. On 11 June 2009, Dr Margaret Chan, stated that nearly 30,000 confirmed cases have been reported in 74 countries. However, by 15 July 2009 the WHO website announced the spread of he Influenza A (H1N1) virus that first surfaced in Mexico and USA, to many more counties. The list included countries such as : Algeria, Antigua and Barbuda, Argentina, Australia, Austria, Bahamas, Baharain, Bangladesh, Barbados, Belgium, Bolivia, Bosnia and Hezegovina, Brazil, Brunei Darussalam, Bulgaria, Cambodia, Canada, Cap Verde, Cayman Islands, Chile, China, Colombia, Cook Island, Costs Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, E1 Salvador, Estonia, Ethiopia, Fiji, Finland, France, Germany, Greece, Guatemala, Guyana, Honduras, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Laos, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Macedonia, Malayasia, Malta, Mauritius, Mexico, Motenegro, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Norway, Oman, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Oatar, Romania Russia, Saint Lucia, Samoa, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Syria, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kindom, United States of America, Uruguay, Vanuatu, Venezuela, Viet Nam, West Bank and Gaza Strip, Yemen.

SWINE FLU AND PIGS

In popular parlance, the illness caused by the new influenza A (H1N1) is called Swine flu. Even scientifically, the causative organism is described as "swine-origin" flu virus as it is a re-assortant strain from swine influenza viruses. Re-assortment is the mixing of the genetic material of two similar viruses. The virus responsible for the current imminent pandemic is a genetic mixture of swine, bird and human viruses. Unlike other strains of Swine flu that infect people and are spread only from pig to person, this new strain of new influenza A (H1N1) seems to spread easily from person to person. Despite the name Swine flu, WHO has not reported any confirmation of transmission of the new influenza A (H1N1) between pigs and humans. The virus also has not been shown to jump to people through eating properly handled and well-cooked pork and pork products. It is killed by cooking temperatures of 160°F/70°C, which is the temperature most meats are cooked at anyway.

SYMPTOMS

Most patients infected with the new A (H1N1) virus have experienced sore throat, cough, runny nose, fever, malaise, headache, joint/Muscle pain. Some reported vomiting or diarrhoea. A few others developed severe acute respiratory illness/infection (SARI) or pneumonia and required hospitalization. ***Human deaths have been reported from Mexico (42) and USA (2).***

VIRAL TRANSMISSION

When infected people cough or sneeze, infected droplets contaminate their hands/surface, or are dispersed into the air. Others nearby breathe in contaminated air, or touch infected hands or surfaces, and thus are exposed to the virus. Human-human transmission is the way the virus is spreading in human populations. The second mechanism of transmission is a more gradual process. It is called adaptive mutation, whereby the capability of the virus to bind to human cells increases with subsequent infections.

PREVENTION

The simple steps of covering mouth and nose with a tissue when coughing, and washing hands thoroughly, with soap and water, especially after coughing and sneezing can cut down the transmission rate of the virus. The surroundings must be kept clean using readily available household cleaning agents. Those experiencing symptoms should seek medical help promptly and avoid contact with people.

It is advisable to wear a mask, while caring for an affected person. The patient should be isolated and kept at a distance of at last 1 metre from others. The room in which the affected person is confined should ideally have excellent ventilation as there should be improved air flow in the area. Doors and windows may be opened to take advantage of the breeze. The patient must be encouraged to rest and to take plenty of fluids. Used tissues and face masks must be disposed properly after use.

TREATMENT AVAILABLE

Inhibitors of neuraminidase such as oselatmivir and zanamivir ; and adamantances, such as amantadine and rimantadine are the two classes of antiviral drugs for influenza. It appears that the new H1N1 viruses are sensitive to neuraminidase inhibitors but resistant to the adamantanes. The latent fear, of course is that the virus may develop resistance to the antiviral drugs used for influenza.

According to WHO, it has a global stockpile of approximately 5 million adult treatment courses of oseltamivir. It has arranged the first deployment of antiviral drugs from this stockpile to 72 countries, giving priority to vulnerable countries, taking into consideration national manufacturing and procurement capacity. It is also distributing about 3 million adult treatment courses to developing countries in need.

WHO is technically collaborating with the Government of India for undertaking interventions to prevent the new influenza A (H1N1) infection in the country and for rapid augmentation of the country's capacity to implement mitigation measures in the eventuality of a pandemic.

In a Notification published in leading newpapers on 8 May 2009, the Government of India has assured that it is maintaining adequate stockpiles of the drug Oseltamivir Phosphate which will be distributed free, in case the need arises.

However, there have been recent reports that H1N1 viruses which are resistant to the antiviral drug oseltamivir (known as Tamiflu) have been identified in Denkark, Japan and the Special Administrative Region of Hong Kong, China (based on laboratory testing). WHO considers that these appear to represent sporadic cases of resistance.

WHY NO VACCINE YET ?

There is no effective vaccine against the new influenza A (H1N1) virus on the shelves. This is because vaccines generally contain a dead/weakened form of the circulaing microbe. For the vaccine to work well, the virus (dead/weakened) in it should match the circulating "wild-type" virus closely. Since the H1N1 virus is a new one, there is no vaccine currently available that has been made with this particular virus. But as soon as the first human cases of new influenza A (H1N1) infection became known, the WHO Collaborating Center in Atlanta (The Centers for Disease Control and Prevention), USA, began the work to develop candidate vaccine viruses. WHO also initiated consultations with vaccine manufacturers worldwide to facilitate the availability of all necessary meterial to start production of influenza A (H1N1) vaccine.

Vaccine production depends upon how swiftly the cultured virus grows in the laboratory. Some strains grow better than others. The behavior of the A(H1N1) strain is not yet known. Also, the estimated time to make enough vaccine to vaccinate the world's population against pandemic influenza will not be known until vaccine manufacturers determine how much antigen (dead/weak virus) is needed to make one dose of effective influenza A (H1N1) vaccine However, making a completely new influenza vaccine usually takes five to six months. The vaccine has to be stored at temperatures between 2°C–8°C.

It is expected that National authorities will implement vaccination campaigns according to their national pandemic preparedness plans. Since this is a new vaccine, close monitoring and investigation of serious adverse events (in any) following administration of vaccine will be deemed essential. It has also been pointed out that, new diseases are, by definition, poorly understood and Influenza viruses are notorious for their rapid mutation and unpredicatable behaviours. The fear is that the virus may (or hopefully may not) mutate into a more dangerous form. Close and constant monitoring will be needed to mount a swift response; should this happen. On 7 July 2009, the Strategic Advisory Group of Experts (SAGE) on Immunization held an extraordinary meeting in Geneva to discuss issues and make recommendations related to vaccine for the pandemic (H1N1) 2009. The experts identified three different objectives that countries could adopt as part of their pandemic vaccination strategey :

- Protect the integrity of the health-care system and the country's critical infrastructure ;
- reduce morbidity and mortality ; and
- reduce transmission of the pandemic virus within communities.

LEARNING FROM EXPERIENCE

However, the situation may not be as bleak as it sounds. Preparedness measures undertaken because of the H5N1 Avian Influenza outbreak have proved to be a blessing in disguise.

The outbreak of highly pathogenic Avian Influenze began in South-East Asia in mid- 2003. It was the largest and most severe on record.

Avian Influenza viruses are highly species-specific and do not normally infect humans being limited to birds and, less commonly, pigs. Of the few Avian Influenza viruses that have crossed the species barrier to infect humans, H5N1 has caused the largest number of cases of severe disease and deaths. The South-East Asia Region alone, accounted for at least 13 deaths from Avian Influenza A (H5N1).

"Bird flu," as the H5N1 Avian Influenza was promptly dubbed, is an infectious disease of birds caused by type A strains of the influenza virus. The infection can cause a wide spectrum of symptoms in birds. The "low pathogenic" form causes only mild symptoms (ruffled feathers, a drop in egg production) and may easily go undetected. Only some viuses of the H5 and H7

subtypes are known to cause the highly pathogenic form of the disease. This pathogenic form speads very rapidly and may cause upto 100 per cent mortality, often within 48 hours. Considerable circumstantial evidence suggests that migratory birds can introduce low pathogenic H5 and H7 viruses to poultry flocks, which then mutate to the highly pathogenic form.

In most cases, the people infected had been in close contact with infected poultry or with objects contaminated by their feces. Exposure to the virus also happened during slaughter, de-feathering, butchering, and preparation of poultry for cooking. Those periurban or rural households that kept poultry under congested conditions risked maximum exposure because the birds shed large numbers of virus in their feces. Consumers ran the risk of cross-contamination if juices from raw poultry and poultry products were allowed, to touch or mix with, items eaten raw ; or if poultry products were improperly cooked before consumption.

The disease caused by H5N1 followed an unusually aggressive clinical course. Primary viral pneumonia and multi-organ failure were common. More than half of those infected (mostly healthy children and young adults), died.

DANGER FROM AVIAN H5N1

The causative agent, the H5N1 virus, has still not been totally eradicated despite the death/ destruction of an estimated 150 million birds. It is now considered endemic in many parts of South East Asia. The firmly entrenched H5N1 virus with expanded its host range, infecting and killing mammalian species previously considered resistant to infection is a harbinger of future pandemics.

GOOD NEWS ON THE NEW INFLUENZA (H1N1) FRONT

On 6 May 2009 it was announced that the full genetic sequencing of the H1N1 swine flu virus has been completed. The breakthrough was achieved by Scientists at the Public Health Agency of Canada's microbiology lab in Winnipeg, who studied the genetic makeup of viral samples from Mexico and two Canadian provinces. This is a tremendous boost to finding the virus's Achilles' heel and in designing a vaccine.

FURTHER READING

1) http://www.who.int/csr/disease/swineful/en/

2) http://www.oil.co.za/index.php?art_id=nw20090506191835578C369647&click_id=31&set_id=1

3) http://www.nlm.nih.gov/medineplus/h1n1fluswineflu.html

DO YOU KNOW ?

Q7. What is the maximum velocity of free fall for a human sky diver ?

Q8. A red curtain looks red because it absorbs only this colour from the full spectrum of the sunlight. Right or wrong ?

Q9. On an average, how much does a crawling baby crawl per day ?

SOMETHING TO THINK ABOUT

HOW IMPORTANT ARE THE BIOFUELS?

Hem Shanker Ray

Global warming and climate change have essentially resulted from severe distortion of the carbon balance in nature. In earlier times carbon dioxide released into the atmosphere by living creatures and combustion processes were absorbed by plants to produce biomass and then release oxygen back to the atmosphere. Carbon dioxide was also absorbed by the sea to create and sustain marine animals and biomass such as algae. There was not perfect recirculation of carbon though because natural processes created two 'wastes', namely coal and petroleum. Plant matter deposited under layers of earth produced coal when geothermal conditions over millennia induced the buried plant matter to undergo metamorphosis. Similarly petroleum was produced by decomposition of marine animals under heat and pressure. However, coal and petroleum were benign wastes of nature's cycles and they essentially lay buried under earth until man started exploiting these deposits for energy production.

Today our industrial civilization releases into the atmosphere far more carbon dioxide than what can be absorbed by the greenary on land and water in the sea. CO_2 level has been rising steadily from the eighteenth century and the rise has been particularly rapid during the last few decades. Shah Jehan perhaps breathed an air that had 280 molecules of CO_2 per million molecules of air. That CO_2 level today stands at about 380.

* Emeritus Scientist, Central Glass and Ceramic Research Institute, Jadavpur, Kolkata–700032. Email : hs_ray@yahoo.com

Coal and petroleum were not unknown in ancient times. But the use of these fuels was very limited in the absence of large industries. Today increasingly huge amounts of coal are needed only for generation of electricity in thermal power plants and petroleum mainly sustains the vast network of the transportation sector. In either case, millions of tons of CO_2 are released into the atmosphere every year. There are numerous other industries which also produce CO_2. For example every ton of cement, produced by rotary kilns through decomposition of limestone, produces nearly a ton of CO_2 also which is released into the atmosphere. If CO_2 level in the atmosphere is not brought down, then man may be heading for 'ecocide'—a term that has been coined by some experts to mean self-destruction because of willfull but unwise alteration of the environment. Some even believe that it may be too late already and this century is likely to see the end of the human civilization that has been built over many millennia.

Biofuels are meant to fight against climate change by decreasing our dependence on nonrenewable deposits of coal and petroleum. They are combustibles that come from renewable biomass. Only the carbon that comes from renewable biomass will be released into the atomsphere when biofuels burn.

Today global ethanol production is over 50 billion litres per year and biodiesal is about 10 billion litres. Ethanol is produced from crops such as sugarcane and corn and biodiesel from oil crops.

Such as jetropha. The U. S. has the largest biofuel industry, 23 per cent of the corn crop alone goes into ethanol production that provides 3 per cent of national transportation fuel. Worldwide less than 1 per cent of transportation is by biofuels as of now.

Huge amounts of funds have already been spent on biofuel research and the technology is gaining momentum. Some experts believe that this funding is misdirected because there is vast scope for savings in the traditional transportation industry. The contribution of the entire biofuel industry can be easily matched by simply achieving one extra km per 2-3 litres of gasoline which is equivalent to around 2 per cent increase in mileage. This can be easily achieved by better traffic management, better maintenance of the vehicles and better roads. If these are done, then there will be added advantages of faster traffic, less number of accidents and lesser maintenance requirements of vehicles and, accordingly, financial gain for vehicle owners. The Golden Rectangle Highway Project of the Govt. of India is estimated to cost some 55,000 crores but this money will be recouped in 7-8 years time through better fuel utilization alone.

Yet all alternative sources of energy are being examined seriously and biofuels present an important option. Some interesting facts about biofuels have been discussed in a recent article (Not your father's biofuel, Nature, vol. 451, 21 Feb. 2008, pp. 880 - 883) and some of these are briefly presented.

Some people hope that even though biofuels are unlikely to account for a large proportion of the total energy use, they can have an important role if we learn to grow the right crops and make the right biofuels. Sometime ago the well known Consultancy firm Mckinsay and Co. suggested that at oil prices above $70a barrel, cellulosic feedstocks could supply half of the global transportation fuels by 2020. Apparently, this was too optimistic and the report perhaps ignored many real world constraints. The oil price has already touched $140 a barrel once.

Biofuels can come from crop residues, grass or woody materials that avoid use a sugarcane or starch to produce ethanol and oil crops to produce biodiesal. Attempts are being made to use marginal lands, attain higher productivity from less land and use land where conventional crops cannot be grown.

The biofuel industry, however, faces many constraints some of which are as follows.

- Strong vested interests that desire to continue with traditional fuels
- Divergence of views regarding prioritization of R & D spending on alternate energy sources.
- Protests over use of land for biofuels because land is needed for agricultural production for man and animals
- Diversion of corn and sugarcane for biofuel consumption and apprehensions about shortages for human and animal consumption
- Need for energy for irrigation and production of fertilizers in production of biofuel crops.
- Mismatch between centres of biofuel production and centres of maximum usage and energy needs for transportation etc. etc.

However, in today's energy scenario it has become imperative that all opportunities for multiple approaches be explored. Biofuels may be the perfect answer in some selected sectors.

The key to producing biofuel is converting sugars into ethanol by an engineered bactirium. Sugars usually come from sugarcane or corn. If cellulosic biomass can be efficiently converted into sugar then various agricultural sources can provide a wider feedstock. Cellulose is the tough polymer from which cell walls of plants are made. Use of cellulosie matter will avoid biomass that is used for man or animals.

Unfortunately cellulose breakdown needs not only heat and catalysts but also biology, and the biotechnology is still not that successful.

Energy crops will need fast growing cellulose that needs no extra inputs of fertilizers. Some fast growing grasses that can be grown in marginal lands will provide the ideal answer. Now there is need to grow crops differently from what man has done over the millenia–designing plants that are better to eat with more sugar in cane (which is also a kind of grass) and more starch in corn.

There is another approach that plans to do away with use of land altogether. Some scientists are developing bioreactors that will tap CO_2 streams from coal based thermal power plants to produce rich algae crops. Also getting some algae to secrete hydrocarbons in a form that can be continuously collected for use as a fuel. Some others are trying to convert other carbon based feed stocks, agricultural waste or municipal waste into carbon monoxide and hydrogen which can then be converted to a liquid fuel nonbiologically. This, however, will not be a biofuel.

Biofuels face another peculiar problem. The microorganisms that are induced to convert the biomass into biofuel are often not immune to what they produce. In fact, the biofuel may be toxic to these microorgansims themselves. The bacteria may thus die and the conversion process stops. Or else, the microorganisms may tend to evolve away from what they are required to do.

So, there are problems but biofuels are definitely here to stay. How important they will be in decades to come will depend on factors such as price to petroleum, progress in bioscience and technology as well as international relations and hopefully, a pardigm shift in man's awareness about the dangers of the climate change.

ANSWERS TO "DO YOU KNOW ?"

A1. Archery.

A2. Yes, Siliguri Station with Broad, Metre and Narrow gauge-all active.

A3. One who studies butter fly and moth.

A4. From either Hebrew first two letters–Aleph and bet or Greek two letters Alpha and Beta.

A5. It should be the same for both.

A6. Salamander.

A7. About 500 Km/hr. head down.

A8. Wrong. The curtain absorbs everything except red.

A9. About 200 metres.

KNOW THY INSTITUTIONS

MICROBIAL CONTAINMENT COMPLEX, PUNE

Microbial Containment complex, Pune is established for providing reliable diagnosis, effective prophylactics, vaccines and other strategies for prevention and control of viral diseases by creating centers of scientific excellence, safe workplace and risk-free environment.

Mandate

Establishment of containment laboratories to facilitate study, storage and safe handling of highly infectious viruses.

- To create centers of excellence for study of high-risk and novel viruses.
- Establishing National Virus Repository and Serum bank.
- Providing teaching and training programs on bio-safety and bio-containment.
- To establish rapid response team to investigate epidemics of viral origin.

History

During seventies, following scientific debate, strong feeling was generated in developed Countries that studies on microbial agents particularly viruses needed much better facilities, more care and caution to avoid health hazard to the laboratory personnel as well as to the population in general. Newer diseases caused by unkown as well as known pathogens were emerging and re-emerging in different places and geographical areas. Due to these concerns, in 1978, the Department of Science

and Technology (Government of India) suggested creation of containment laboratories under ICMR. The council decided that this facility should be developed as independent national facility under National Institute of Virology, Pune. The Planning Commission sanctioned a small amount of token money for setting up of such a laboratory. NIV acquired about 27 acres of land in on the outskirts of the city at Pashan, Pune. Road and compound wall were constructed. Water, electricity was obtained from far off places. It took serious effort and considerable time to develop the land.

As there was no expertise in the country to set up containment laboratory, two scientists of NIV visited some of the existing high security laboratories in Britain and USA. With the help of other experts in the country a plan for creation of such a laboratory was developed. An Expert Committee was constituted to guide and advise on establishment of Microbial Containment Complex (high containment facility). The Committee suggested phasing out of construction activity. In first phase, it was planned to create the facilities that did not require advanced expertise and competence to erect them.

i. High containment Facility is developed as a National Infrastructure to handle high-risk micro-organisms.

ii. Specialized facilities / equipment that rank among the best five in India.

Basic Laboratory Building :

This is a big and elegant building (area about 7500 sq m) having ground plus 2 floors. Annexed to this building are library hall, conference room, and infected animal holding block. Several BSL-2 labs have been created in this building.

High Containment Laboratory :

NIV/MCC scientists prepared concept and design of the laboratory. The laboratory consists of molecular biology, serology, tissue culture, entomology, material staging, and animal holding rooms. Other special features of the laboratory are as follows :

- Cadaver storage facility
- Eco-friendly monkey-runs
- Conference & meeting halls
- Incinerator attached to BSL-3 facility
- Eco-friendly garbage disposal system (vermiculture-pits)
- Guest house
- Staff quarters
- Support BSL-2 laboratory
- Novelty / Innovative

The High Containment Bio-Safety laboratory is a state-of-art biosafety Level 3+ laboratory. It has been planned and designed as per guidelines of Center for Disease Control and Prevention (CDC) Atlanta, USA and WHO, Geneva. Here scientists will be able to go one step further to explore the domain of the unknown viruses such as SARS, Nipah, Hantaan that have been flirting in India causing national havoc. MCC will also serve as a National Virus Repository, where viruses are archived for further research.

● Brief Highlights of the High Containment Laboratory

High containment (BSL-3) laboratory facility of MCC is a separate building. The specialty of this containment facility is that it is planned and designed to handle majority of infectious work in primary barriers (biosafety cabinets class-II type B-II and class III isolators). To provide high security to laboratory, proximity cards and codes restrict entry.

This laboratory is designed and provided for work with those organisms that present a high risk to laboratory personnel and to the community. All the laboratory personnel are to be specially trained in handling pathogens and potentially lethal

agents and are to be supervised by competent scientists who are experienced in working with these agents. All procedures involving manipulation of infectious agents are conducted within biological safety cabinets or other physical containment devices or by wearing of appropriate personal protective clothing or devices. The laboratory is equipped with specific design features and follows special practices.

Specialized Development

ICMR has its mandate to discover therapies, vaccines and rapid diagnostic tools against viruses and other agents to protect the citizens of India. Emergency response to Natural occurrence (Zoonotic, Exotic etc.), Bio-terrorism & Biological Warfare (tactical and god forbid strategic) requires in addition to the hospital/healthcare infrastructure the construction of regional hospitals and containment facilities. ICMR has formulated a plan of preparedness to deal with such emergencies. NIV/MCC is set to play a critical role in this endeavor. A rapid response would be mission critical since the citing of the index case and assessing the R-Zero would make a world of a difference in identifying the correct containment strategy.

Superiority / advantage over Similar Developments Globally

India and neighbouring countries are extremely prone to many emerging and reemerging infections due to developmental programs such as clearing of forests, new roads and highways, increasing air and rail travel, and unplanned urbanization.

Traditionally, we have been depending upon developed countries to provide specific diagnosis as they have the requiste labs and technologies. Critical High containment (BSL-3) laboratory will provide us ability to deal with such emergencies and reduce the dependence on developed nations. Thus development of facility where it is needed most is our advantage over other facility of similar type.

Database (including repositories) Developed

The virus strains available are being characterized at molecular level and basic database is being generated. Such data is an asset to any country.

Services Rendered in Times of National Calamities

During 2003, during global outbreak of SARC in the month of April and May, suspected SARC cases started appearing in this country. MCC was the only laboratory, which had facilities to handle such high-risk samples. This center played important role in safe processing samples for the diagnosis.

The facility provided critical input during an outbreak of Chandipura, which claimed life of over 150 children in A. P. and similar number in Maharashtra during 2003.

Outstanding Contributions of the Institute / Centre

- Biosafety Level-3 laboratory has been established to work with indigenous or exotic agents.
- Monkey run and biosafety 2 laboratories are built for proper upkeep of laboratory animals.
- Strong scientific and reagent program is taken up to provide timely diagnosis of pathogenic viruses involved in bioterrorism.

Highlights of Newer Initiatives Taken

National virus repositories, molecular diagnostic facilities like Microarray, are being established. Reagents and vaccine development for neglected but important disease are being taken-up on priority.

Contact : Director, Microbial Containment Complex, Sus Road, Pashan Pune-411021, Tel : 91-20-25880982, 25889194, Fax : 91-20-26122669

Conferences / Meetings / Symposia / Seminars

Symposium on 'Bio-safety and Environmental Impact of Genetically Modified Organisms and Conventional Technologies for Pest Management' Theme : Environmental Impact Assesment & The 29th Session of Academy of Environmental Biology, 20–21 November 2009, Patancheru (Hyderabad)

The workshop will address issues related to :

1. Protocols for assessment of bio-safety of conventional technologies and genetically modified organisms to the non-target organisms in the environment.
2. Impact of conventional technologies and genetically modified organisms on the non-target organisms in the environment.
3. Impact of conventional technologies and genetically modified organisms on biodiversity.
4. Policies and guidelines for deployment of conventional technologies and genetically modified organisms for pest management and environmental safety.
5. Toxicity and fate of pollutants in biological systems.
6. Hazardous waste management/risk assessment and Environmental management Programs.

Submission of Abstracts last date 30 sept. 2009.

Contact : *Dr. Krishna Gopal*, Aquatic Toxicology, Indian Institute of Toxicological Research, Post Box-80, M. G. Marg, Lucknow 226001, Uttar Pradesh, India. Email : aeb1@rediffmail.com Tel. : 091-522 2613786 / 2627586 Ext–259, 260 ; Fax : 091-522-2628227.

46th Annual Convention of Chemists, December 1-6, 2009, Vellore Institute of Technology, Vellore.

Research papers in the following sections shall be presented in oral / poster sessions. Some Young Scientist awards shall be given on the basis of scientific contents and presentations (mentioned against names of respective sections)

1. Analytical Chemistry & Environmental Chemistry Section : (i) Dr. Upadhyayyulu V. Rao Memorial Award (ii) Dr. Upadhyayyulu Annapurna & Satyanarayana Memorial Award (iii) Prof. V. Pandu Ranga Rao Award (iv) Prof. A. K. Dey Award (v) Prof. G. Gopalrao Young Scientist Award.
2. Inorganic Chemistry Section : (i) Prof. A. K. Dey Award (ii) Prof. B. C. Halder Memorial Award (iii) Sree B. M. L. Bhasin Memorial Award.

3. Organic and Biochemistry Section : (i) Indian Chemical Society Award.

4. Organic and Biochemistry Section : (i) Dr. D. S. Bhakuni Award (ii) Dr. B. N. Mankand Award (iii) Dr. J. M. Dasgupta Award (iv) Prof. P. Sengupta Memorial Award.

5. Physical Chemistry Section : (i) Prof. Santi R. Palit Award (ii) Association of Kinetics Award. Last date for Submission of Abstract of papers–24 September 2009.

Contact : *Prof. P. L. Majumder*, Honorary Secretary, Indian Chemical Society, 92, A. P. C. Road, Kolkata-700 009. E-mail : priyalalm@hotmail.com.

National Conference on Quality Improvement Concepts and their Implementation in Higher Educational Institutions (QICIHEL – 2009), December 11-12, 2009, Coimbatore Tamilnadu, India

The conference is organized by Department of Mathematics, Amrita Vishwa Vidyapeethan in association with IQAC. The Conference is aimed at the target group from both educational institutions and industries who are either doing research or attempting to implement various quality improvement. The staff responsible for internal Quality Assessment Cells in NAAC certified institutions will also benefit from the Conference.

Contact : *Dr. J. Ravichandran*, Organising Secretary (QICIHEL–2009), Department of Mathematics, Amrita Vishwa Vidyapeetham, Coimbatore-641105, Tamilnadu. Website : www.amrita.edu/qicihei09 Email : j–ravichandran@ettimadai.amrita.edu.

54th DAE Symposium on Solid State Physics, December 14–18, 2009, The Maharaja Sayajirao University of Baroda, Vadodara

Symposium is organized by Board of Research in Nuclear Sciences, Department of Atomic Energy. Government of India. Manuscripts (contributed papers, thesis presentations and YAA presentations) should be submitted by e-mail as a Microsoft Word document. pap_ssps@barc.gov.in.

Contact : *Dr. A. K. Rajarajan / Dr. Alka B. Garg*. Secretary, DAE-SSPS 2009, Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai–400 085, INDIA, Email : daessps09@gmail.com

S & T ACROSS THE WORLD

ZERO DISCHARGE TOILETS

Eco-friendly zero discharge toilets are all set to be introduced in trains across the country. The toilets jointly developed by IIT Kanpur, Research Designs and Standards Organization, Lucknow and a private agency in Chennai, ensure that all liquid discharges are converted into "pure water" which can be used as re-cycled water to flush and clean toilets and sanitary fittings. The solid waste is converted into odour free paste by certain bio-chemicals or additives applied at the departing terminal. This can be stored for 15 days in a tank and can easily be emptied at the destination point through pressurised evacuation.

The odourless solid waste could yield revenue since the paste would form an excellent manure after being dried in the sun. After some more trial runs and studies the scheme would be a permanent feature in Indian Railways.

Presently, the system has been installed in trains running between Chennai and Jammu Tawi and Chennai-Lucknow.

(PTI Science Service, Mar 1-15, 2009)

BIOCONTROLLING CONGRESS GRASS

Congress grass or parthenium, a native of tropical America, came to India accidentally in 1955. A rapidly growing invasive species, this grass competes well for nutrients and space and reproduces fast. One of the world's seven most notorious weeds, parthenium has already taken over about five million hectares of this country's land. Many methods, ranging from manual uprooting, chemical herbicides to biological control agents, have been proposed to limit the spread of this uncontrollable variety of grass. Biocontrol agents are the most preferred as they are inexpensive and cause few side-effects.

Quite a few bioagents, including the leaf beetle, Zygogramma sp, and the rust fungus, Puccinia abrupta, have been used in the management of parthenium in different parts of the world with some limitation in field trials. Further need based research is continuing in this area.

(Down to Earth, Feb 16-18, 2009)

GREEN RATING FOR BUILDINGS

Bureau of Energy Efficiency is reportedly extending the star rating scheme to buildings as well. The ratings, meant only for offices at present, will award certificates to buildings based on their energy consumption over a period of at least one year. Organizations that apply to BEE will be assessed on their power consumption and awarded star ratings from one to five, with five signifying a highly efficient building. It takes off from the energy conservation building code that had been enforced in May 2007. So far around 500 buildings have been designed according to it.

Benefits are likely to motivate builders to adopt better construction practices. However, only existing buildings will benfit from the programme since a building has to be in existence for at least one year to qualify for the audit. New buildings can probably take tips from LEED or GRIHA codes developed by separate organizations for energy efficient buildings so that when they are finally assessed, they can get a good rating.

(Indian Building Congress, Mar, 2009)

MICROBES TO SOLVE ENERGY CRISIS

Microbes may well be the answer to our global energy crisis. By fermenting biomass to produce biofuels, they offer a possible climate-friendly solution to the anticipated shortfall in fossil fuel supply. Global oil reserves and new petroleum discoveries will not be enough to meet the annual demand worldwide. It is, therefore, essential to anticipate and avoid any shortfall in future supply and to provide access to new bioenergy alternatives for the marketplace. In the context of a strong global political and economical debate on the gradual substitution of petroleum by renewable alternatives, such as biofuels, microbes can help solve the energy problem, and focuses on the organisms that ferment lignocellulosic biomass to produce bioethanol, biobutanol, biodiesel and biohydrocarbons in particular.

Use of these biofuels would help reduce green-house gas emissions. Also there have been a number of US government initiatives pushing for and backing the develpment of biofuels. Finally, what remains is a major effort and challenge to biochemical engineering at the many new plants being built for biofuel production. Processes have to be scaled up and carried out in cost-effective way.

(Chemical Weekly, Feb 17, 2009)

NEW SHOCK ABSORBER

A new shock absorber developed by a team of researchers from the Massachusetts University of Technology, USA, can generate electricity to fuel your vehicle when it hits a bump. The group used different car models, fitted the suspension with sensors and drove around. The tests showed a significant amount of energy wasted, specially in heavy vehicles.

To find methods to harness wasted energy, scientists replaced the suspension system with a contraption consisting of a hydraulic system that forced the fluid through a turbine when the vehicle hit a bump. The turbine was connected to a generator that converted mechanical energy to electrical energy. The electrical energy was used by the vehicle, thus saving energy. The system can operate in vehicles which are completely battery-driven or run on a combination of fuel and battery (hybrids).

Calculations indicate the heavy vehicles could increase their fuel efficiency by 10 percent with this new shock absorber. The group filed for a patent last year and formed a company called the Levant Power Corporation to develop and commercialize the product.

(Down to Earth, Mar 16-31, 2009)

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2. Manuscripts should be typewritten on one side of the paper with double spacing. Articles should be written generally in non-technical language and should not ordinarily *exceed 2000 words.* Articles must be understandable by the average enthusiastic readers with some modest scientific background but outside the field. It should not be a review article in a specialised area. Without being too technical, it must also reflect state of the art situation in the field. *A summary* in 50 words should be submitted along with the paper highlighting the importance of the work. *Two copies* of the manuscript complete in all respects should be submitted. The title should be written in capital letters and name(s) of the author(s) should be given along with the Department, Institution, City and Country of each author.

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THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, DR. BIRESH GUHA STREET
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INSTRUCTION TO AUTHORS FOR PAPER PRESENTATION AT THE 97TH INDIAN SCIENCE CONGRESS TO BE HELD AT KERALA UNIVERSITY, THIRUVANANTHAPURAM, DURING JANUARY 3 TO 7, 2010

PAPER PRESENTATION (ORAL/POSTER)

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