LEARNING TO LIVE WITH SCIENCE AND TECHNOLOGY

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I consider it a great honour to be invited to deliver the Founder Memorial Lecture this year. This lecture series is distinguished on two counts. First, it pays tribute to an industrialist who did not rest on his laurels as a successful businessman but had the broader vision of a humanitarian, a vision which he transformed to reality in many practical ways. The second aspect in which this lecture series is distinguished is through the galaxy of speakers who preceded me in the previous years. In delivering my lecture today I am conscious of these aspects as well as of my own limitations.

Although my subject of specialization is theoretical astrophysics, I have, in recent years been concerned also with wider aspects of science. Partly, this may be due to the fact that the subject of astrophysics takes you all over the universe, to a study of the applications of the basic laws of science in situations far beyond the imagination of the typical inhabitant of this humble planet. Indeed, in one of the preceding lectures of this series Professor M.G.K. Menon talked on 'The Frontiers of Astrophysics'. Someone like me who works on these frontiers is almost forced to view the world beyond the rather narrow confines of 'here and now'. Astronomy, more than any other subject, brings home to us the realization of what the laws of science are capable of. Let me therefore begin my talk with an example from astronomy.

Why Does the Sun Shine ?

This question is probably one of the oldest questions of science. Ever since man set his eyes on the glowing ball that is the Sun, he has wondered and speculated about the cause of its brightness. The divine status accorded to the Sun in ancient mythology was because man could not rationalize within his available store of experience and knowledge to find an answer to this question.

As late as fifty years ago this question was still unsolved, although astrophysicists were beginning to have a glimmer of the correct answer. Key roles in these investigations were played by Sir Arthur Eddington in the U.K. and Hans Bethe in the United States. It was Eddington in the 1920s who maintained, in spite of criticism from the physicists, that the energy responsible for the Sun's brightness was generated by a fusion of atomic nuclei deep in its interior. Eddington's calculations had led him to temperatures of several crore degrees in

the interiors of stars and he had conjectured that nuclear fusion could be achieved there. Atomic physicists, however, felt that these temperatures were not high enough to induce fusion. To such objections Eddington made his now famous retort :

"We do not argue with the critic who urges that the stars are not hot enough for this process; we tell him to go and find a hotter place".

The progress of nuclear physics during the 1930s resolved the controversy in Eddington's favour. Yes; the Sun is hot enough in its central core to induce nuclear fusion. Hans Bethe constructed a mathematical model of the Sun to demonstrate this result.

Coming down to Earth, this story has a moral : "Do not ignore what goes on out there". Today nuclear physicists are engaged in the gigantic task of trying to achieve nuclear fusion in the terrestrial laboratory. Dr. P. K. Iyengar, in his Founder Memorial Lecture on "Impact of Nuclear Research on the Future Technology of Nuclear Power" highlighted some of the problems of nuclear technology. The goal is tantalizing : if we succeed in emulating the Sun we will have solved the problem of energy which is so critical in the present era of technological growth. The difficulties are immense. The Sun manages to produce energy in a steady fashion because it has strong gravitational forces (arising from its own huge mass) to control the process. Lacking these forces on the Earth man must invent other means of achieving controlled thermonuclear fusion.

The Rapid Growth of Science and Technology

Thermonuclear fusion requires bringing together nuclei of hydrogen or deuterium (heavy hydrogen) at temperatures of the order of a crore degrees. The energy released by fusion must be controlled, otherwise it may appear in an explosive form leading to a catastrophe like the hydrogen bomb. A hundred years ago even scientists, let alone lay people, would have considered the above achievement impossible, or at any rate falling in the domain of science fiction. That experimentalists of today are seriously attempting this task is an indication of how far science and technology have advanced in the relatively recent past.

The rapid growth of science and technology on various fronts was illustrated in a dramatic fashion by Alvin Toffler in his book "Future Shock". Toffler's description may be briefly paraphrased as follows. Divide the past period of 50,000 years, over which human history is traceable, into 800 human 'life-spans'. Thus each life-span is of 62½ years which we may consider a typical

length of human life. How has man developed over these 800 life-spans ? That his rate of development has *not* been uniform is seen by the following data.

Of the 800 life-spans the first 650 were spent by man dwelling in caves. Thus for the first 80 percent or so of the period of documented history, man was in an uncivilized state. Taking the art of writing as a sign of culture we can argue that man has been in this state for the last 70 life-spans. While writing is a means of recording one's thoughts and experiences for posterity, printing, requires technology and it ensures that the writing is made available to a larger readership. This technology has been in existence over the last 6 life-spans only.

Watches measuring small time intervals became available in the last *four* life-spans while the electric motor which is so useful and indispensable now-a-days came into existence only in the last *two* life-spans. In fact an urbanite today can verify that most of the items and gadgets he uses in his daily life owe their origin to the *last*, the 800th, life-span. The electronic computer was developed in the last half life-span while the space age began only a third of the life-span ago.

Another way of highlighting the rapid growth of science and technology is to ask this question : "What fraction of *all* the famous scientists and technological inventors from the early history of man to the present day, are alive today ?" The answer, by my reckoning, would be : "Well above 75 percent".

This rapid growth of science and technology has placed strain on our society. Imagine a person attending a feast of delicious food, being tempted to eat all food items very rapidly. He will naturally find the experience discomforting to say nothing of the subsequent strain on his digestive system. Likewise, although science and technology offer us numerous goodies, these offers are coming so fast that the recipients are put under considerable pressure. There is an obvious need to react to the situation in a rational rather than in an emotional way.

It is worth emphasizing that the problem is not confined to developing countries like India. It is being faced, perhaps even more acutely, in the developed countries also. In India, we have an additional factor to consider, viz : the heterogeneity of mode of life. We have the bullock cart side by side with the jet plane, road-side astrologers and palmists side by side with space scientists, exorcists side by side with advance researches in medical sciences, to say nothing of the grave disparity in the standards of living of the rich and the poor.

Lessons from History

One solution to the above problem might be to have nothing to do with science and technology. It is tempting to argue that by turning our backs to science, by going back to the simple ways of nature we will restore tranquillity to human society. Indeed many, especially in India, do argue this way. They point to the breakdown in the accepted moral order in the highly industrialized countries of the West, and exhort us to abandon the track of science and technology followed by these countries.

To me this appears a defeatist attitude. We do not advise a patient to abandon the medicine just because he finds it bitter. To carry the analogy further : medicines come in various forms and types. It may happen that a course of medicine has to be abandoned if it proves ineffective. There are also medicines which cure the main complaint but cause side reactions. Such medicines are continued for their therapeutic value while side reactions are controlled by other medicines. With science and technology we are in this last category. We have to find ways of controlling harmful side effects from the use of science and technology—side effects which I will discuss later—because its main effect can be very beneficial to human life. To abandon the track of science and technology for fear of the side effects would be extremely shortsighted.

Indeed, if history is any guide we will find that appreciation of science and technology has always paid off in the long run while a non-recognition of its existence and implications has proved to be short-sighted. In the ancient days there are several stories of the ingenious devices used by Archimedes. His screw for lifting water, his deployment of levers for moving weights, his use of gigantic pulleys to pull up the enemy ships are examples of what science and technology can do to help those who want to use them. In the early days of industrialization in England, the steam powered railway engine encountered a lot of opposition, largely from those who had irrational fears of steam power. Gradually, however, the railway train pulled by a steam engine became an accepted mode of transport of human beings as well as of freight.

We, in India paid a heavy price for not appreciating the value of science and technology at a time when it was beginning to flourish in Europe. It has always been a mystery to me that whereas arts, architecture, literature and music fluorished in this country and found royal patronage at various levels, science remained unknown or unappreciated. Why did this happen ? Did it happen for lack of contact with the West ? In the much earlier epochs of Aryabhata and even Bhaskara, such contacts were not uncommon and astronomy had fluorished

as a science, thanks to interchanges of ideas between, China, India, Arabia and Greece. Somewhere along the line this tradition appears to have broken down. But it is difficult to believe that from the seventeenth century onwards, India was isolated, newswise, from Europe.

Why did not India have its own scientists ? Why did the mighty Moghal empire which produced a Tansen and Taj Mahal, fail to produce a Newton or a Faraday ? The argument that India was riddled with wars and that life was insecure, does not hold water. Europe in those days had its fair share of wars. Living conditions in Europe were no more secure than in India. Again, I feel the reason must lie in an apathy towards the new ideas that science was bringing in Europe. The word 'apathy' is supposed to include ignorance as well as lack of urge to learn. Historians of science should provide us with a more comprehensive assessment of the situation than what I have sketched here.

The fact remains, however, that in the days of the expansion of the British and the French empires our kings had to rely on inferior armaments or on what the British or the French chose to supply, often at heavy price. Although history books tell us about the British diplomacy of divide and rule which led to the spread of British domination in India, I feel that even if the British had not come, India with its non-existent store of science and technology would have fallen prey to some other technological power. By turning our backs to science now we would be repeating the mistake of our forefathers.

The Benefits of Science and Technology

Let us turn our sights from the past to the future. What benefits do we expect from science and technology if it is allowed to continue its progress unabated ? Shortage of time prevents me from indulging in futurology to the extent that I would have liked. Let me therefore select a few areas which are going to play key roles in the future development of our society. Here again, the list is only a partial one from what I could have chosen.

a) *Energy Sources*. The twentieth century will go down in history as the period of the rise and fall of oil as the main source of energy. Experts disagree in the extent to which oil will continue to be the main source of energy in the future. Indeed oceans may reveal vast oil reserves which a future technology can tap. Nevertheless the geographic location of oil reserves will necessarily raise political questions. To avoid these man has to look for other sources of energy. Two means suggest themselves.

One is the source from nuclear fusion which I mentioned before. Unlike the fission reactors which require special fuels, thereby raising political issues of supply, the fusion reactors would work on heavy hydrogen which is commonly available in sea-water. It is hoped that the technological problems involved in the construction of a viable fusion reactor will be solved in the next two or three decades to enable man to tap this vast resource of energy.

The other source of even greater abundance of energy is the Sun. The amount of energy which daily falls from the Sun on the Earth in the form of sunlight is immeasurably greater than the daily energy needs of all human population today. And this energy source is expected to continue for hundreds of crores of years, according to the astrophysical estimates. Here then is the ideal energy reservoir right at our doorstep. Can we tap it ?

Solar energy is being used by us directly, as well as indirectly. When we dry our clothes in the sunlight, when we burn wood from trees for fuel we are benefitting from solar energy. Yet these uses are like using drops from oceans. Can we achieve a greater efficiency in the energy tapping process ?

b) *Space Technology*. The answer to the above question is very likely to come from man's conquest of space. Up above the Earth's atmosphere, can we station a gigantic receiver which would collect sunlight, convert it into electrical energy and beam it to Earth based distribution centres ? The suggestion appears too outrageous to be put into practice : but then going to the Moon was also once part of science fiction rather than practical science ! The technological expertise needed is not beyond human ability. The costs are stupendous : they have been estimated but are probably unrealistic since the value of money is very difficult to predict even for a short term future. It is pointed out, however, by the protagonists of this project that most of the costs are capital costs. The production costs are negligible by comparison since the Sun does the energy production free !

A modest beginning towards space technology has been made. The spacecraft Columbia has shown how it is possible for man to return to Earth in a controlled fashion and to reuse the spacecraft for future flights. Laboratories in space are now a reality. From laboratories to workshops is the next step.

Working in space in near-vacuum and away from the domination of Earth's gravity is going to herald new technologies. Huge structures can be erected in space from light materials, new alloys and welding processes are possible in the near-vacuum of space, even medicines of a new kind could be made.

These are long-term achievements to come in future. The SITE programme has already shown what can be done for mass education of rural population in remote and inaccessible areas. Indeed, man-made satellites have in a short period brought about dramatic improvements in communications technology.

c) *Biological Technology.* An entirely new area is opened up recently by the experiments in genetic engineering. In a certain sense bio-technology is even older than the conventional technology based on physical sciences. It was known 6000 years ago when the ancient Egyptians used yeast to make bread. Fermentation to make wine, the making of cheese are also examples of bio-technology.

In these age-old examples microbes were used to achieve certain chemical changes. In contrast to the chemical processes in man-made factories which often require conditions of high temperature and pressure these biological processes take place at normal temperature and pressure. The industrial revolution tilted the balance away from these gentle biological processes because of the availability of cheap fuel. Now, with fuel becoming dearer day by day bio-technology is becoming competitive and even more attractive especially when aided by genetic engineering.

In genetic engineering the possibility has emerged that genes carrying specific instructions can be planted on microbes who then carry out those instructions more efficiently. Thus the human growth harmones and the valuable insulin can be produced through the implantation of genes in Escherichia coli bacterium.

Although the subject is hardly a decade old, genetic engineering holds out hopes for numerous practical applications. Nitrogen fixation in plants would enable them to absorb nitrogen directly from the atmosphere rather than to depend on fertilizers in the soil for a supply. Microbes can be used to manufacture drugs which are now-a-days made by conventional technology. What is more, new types of drugs not possible by conventional means are likely to be made biologically. Many of the poisonous pollutants in industry may eventually find bacteria to 'eat' them and thus to remove them from our environment. Indeed, the advocates of genetic engineering argue that so far as the use of this research is concerned the only limitation is of human imagination.

d) *Computerization.* I would be failing in my review if I did not mention the rapid growth in the computer/microprocesser field. During the post-World War II period, while many scientific experiments *grew* in size, while the astronomers

built *bigger* and better telescopes, the progress in electronic computers has been towards *miniaturization*. A small desk-top machine today can do a neater and faster computing job than the huge systems made of vacuum tubes which filled up large size rooms only three decades ago.

Naturally the 'magic chip' which heralded this revolution has led to the spread of the computer to industry, banking, information handling and many other areas in our day to day life. The day of the home computer is almost here. The pocket calculators have become smaller and smaller, yet more and more versatile. Time saving, cost-cutting, energy-economizing . . . these are the adjectives which come to our mind when we talk of such applications of modern electronic inventions.

On a more general note electronics coupled with space technology has dramatically transformed information handling. Arthur C. Clarke's notion of geostationary satellites transmitting messages from one part of the Earth to another has become a reality. And future views of communications technology indeed promise more goodies.

Dangers and Pitfalls of Science and Technology

The goodies I have been describing, however, come attached with a cautionary note. It is very easy to misuse the gifts of science and end up with disaster. Indeed, it is interesting to note that each of the heads I just mentioned under 'benefits' have also brought in headaches.

Take, for example, nuclear power. While controlled thermonuclear fusion is still a remote goal, science has shown us how to use nuclear energy for destruction. The hydrogen bomb has already been made and coupled with the latest scientific inventions of guided missiles it promises to destroy most of the world with ease. Examples of the Three Mile Island type have shown how cautious one has to be in handling nuclear energy even for a peaceful purpose.

Space technology has also brought in vastly improved and efficient means of spying. Space colonies of the future, if allowed to grow without due control can easily bring in space-pollution. Living in a zero gravity environment for extended periods may bring in new mental and physical ailments of which we have as yet no experience. For, nature designed and evolved the human body and mind to adapt them to conditions on the surface of the Earth. Can man quickly readapt them to conditions so different ?

People both scientists and non-scientists have already expressed misgivings against genetic engineering. Here again, man is tinkering with living systems which have long evolved to their present form under natural laws. Science fiction strories tell us of living organisms prepared in scientific laboratories playing havoc with the course of natural life on Earth. Would these fears translate into reality ? Although bio-technology is still in a very primitive stage many governments have adopted a cautious attitude and imposed fairly rigid controls on the experiments in genetic engineering.

A new ethical question has recently emerged in this field. Some giant drug manufacturing firms have sponsored basic research in genetic engineering and related fields in some of the universities in the U.S.A. The condition imposed however, is that the results obtained will become the property of the sponsors. Many scientists see this kind of sponsorship as a threat to the concept of free publication of scientific results.

Finally, the benefits of computerization and automation also mean that man is made redundant. The robot can perform the job more efficiently and economically than man who invented it. How to use the benefits offered by automation without causing unemployment and economic hardship is a problem which will be felt increasingly in the future. Further, even if he is economically well of, man will find himself with more 'free' time. How is he to occupy himself during this spare time ?

I could go on in this vein much longer; but I think these examples will suffice in cautioning us about how to receive new gifts from science and technology.

Future Growth of Science and Technology

Technology follows on the heels of science. Scientific research of today may be followed by technological applications tomorrow. Even the so called basic research which does not aim at applications but is aimed at discovering the riddles of nature can have technological fall-out. Thus what type of technology we want tomorrow will be decided by what scientific research we encourage today. What types of research should be encouraged ?

If this question is put to scientists alone we will not get a practical answer. Scientists will have a number of ambitious projects to suggest. If there were sufficient funds available all these projects could be encouraged. In

reality, however, scientific research has become a big-budget affair. Even experiments in basic research such as the high energy accelerators used by particle physicists or the telescopes used by astronomers or some of the experiments set up by molecular biologists cost amounts running into several crores of rupees.

In most countries the government is the main supporter of scientific research. Private industry and trusts do contribute in various ways but their contribution is dwarfed by state funding. So what research should be encouraged is to be decided by the government agencies funding the research. These agencies usually decide the issue by seeking advice from senior scientists in the field.

This process of peer-judgement has not worked very well. One often hears complaints, especially from those scientists whose projects were turned down, that the handful of committeemen have not done their homework properly. Yet, it is difficult to think of any alternative to this procedure. The only improvement one can hope for is that the decision makers are informed properly about the various research projects and their future implications.

It is hard to make future forecasts about what research will turn out to be important. Even very experienced scientists err in judgement. Lord Rutherford, after successfully 'breaking the atom' felt that his research would have no practical consequences. However, within a decade or so after his death the atomic bomb became a reality. "Space travel is utter bilge", was the comment of Astronomer Royal Sir Richard Wolley when asked about future space ventures following the launch of the Sputnik in 1957. Within twelve years man landed on the Moon. Who could have foreseen the present development of microcomputers in the years just after World War II ?

Science Popularization

To educate the scientists on what goes on in science is difficult enough. Even more difficult is to educate the common man on what science is capable of. Yet this education is essential. For, it is the common man who elects the government which makes the crucial decisions on which areas of science to support. It is the common taxpayer who ultimately forks out the crores and crores of rupees needed for research and development. And the responsibility for this education falls squarely on the shoulders of the scientists themselves

It used to be argued that scientists working in their laboratories are busy people, that their time is too valuable to be wasted on the layman. This argument

grows weaker day by day for the economic reasons I have just mentioned. This statement applies to basic research no less forcefully. Lack of proper information can be catastrophic not only for science but also for human society in general.

For example, in times of economic hardship basic research is liable to suffer most. Since this research does not yield any tangible dividends, at least immediately, it is tempting to economise by cutting back on the funds for such research projects. It is true that in items of hardship and economy drive, basic research projects should be critically reexamined and only those which come up to a very high level of excellence should be supported. An indiscriminate cutback on basic research is suicidal, however. For, this type of research encourages the scientific approach to problems, which is so essential for human progress. I can do no better than quote the words of Dr. Homi Bhabha on the occasion of the opening of the new buildings of the Tata Institute of Fundamental Research :

"...the support of such (fundamental) research and of an institution where such research can be carried out effectively is of the greatest importance to the society for two reasons. First of all, and paradoxically, it has immediate use in that it helps to train and develop in a manner in which no other discipline can, young men of the highest intellectual calibre in a society into people who can think about and analyse problems with a freshness of outlook and originality which is not generally found...".

There is also another aspect of the impact of basic research. If basic research is cut back, many of the ideas essential for applied research may have to be imported from other countries. There arises in this way a direct threat to our self reliance.

Science can be popularized in several ways. Thanks to the gift of communications technology we have several media available for this purpose : the radio, TV, movies, video etc. The written word can go a long way especially in the mother tongue of the prospective reader. Popular science articles and even science fiction stories can create a mood for acceptance and for a critical value judgement of science. In the Western countries several eminent scientists and journalists have been engaged in science popularization. Thus it is no longer below his dignity for the scientific expert to 'talk down' to the layman.

Perhaps the longest tradition of science popularization is found in the Royal Institution of Great Britain. This tradition dates back to the days of

Michael Faraday in the last century. Faraday, himself a great physicist always felt that his research work alone would not be worthwhile if he could not convey it to the layman. He writes in a vein of self-criticism :

"As when on some secluded branch in forest far and wide sits perched an owl, full of self conceit and self created wisdom, explains, comments, condemns, ordains and orders things not understood, yet full of his importance still holds forth to stocks and stones around—so sits and scribbles Mike."

The tradition of Faraday's lectures and lecture demonstrations is carried on at the Royal Institution to this day by distinguished scientists, many of which include Fellows of the Royal Society and Nobel Laureates.

I think I have made a case for popularization of science by scientists. I believe journalists have also a vital role to play in disseminating information about the latest scientific developments to the readers of newspapers and magazines. Science journalism has attained maturity in the developed countries; it is practically non-existent in India where it is needed most. I am dismayed by the fact that columns and columns are devoted to astrological forecasts in our leading newspapers while hardly any news appears about the exciting discoveries in the various sciences. Even if some news item does appear about science, it is either supplied by foreign news agencies or if it is indigenous it contains serious technical errors. Why is science reporting so poor in India ? Certainly there is no shortage of science graduates in our country, of people who could at least attempt the job of describing science news to the average reader. I am told that newspaper economics do not encourage the breed of science reporters ! Since the average reader wants to read astrology he is given plenty of it.

It would be tempting to adapt a well known saying and argue that readers get the newspapers they deserve. That this is a fact of life we have to accept; but can we do nothing to change it ?

Science and the Uncanny

The interest in astrology is part of a general syndrome which drives man to ignore his rational self and to ascribe a supernatural element to something he cannot understand and rationalize. There was indeed a time when planetary motion was ill-understood. Planets appeared to move in an irregular fashion against the background of stars and this led to the supposition that they move

'at will' and are therefore possessed of divine/supernatural power. From this supposition came the belief that planets control human destiny, a belief which forms the basis of astrology.

With the work of Kepler and Newton planetary motion became well understood. Planets do not move at will, but are subject to the laws of gravity and dynamics. Today's man-made space crafts like the Viking, the Mariner and the Voyager can achieve rendezvous with the planets with high accuracy. So there is no more mystery about why and how the planets move. Even on an empirical basis, the astrological claims of relationships between planets and human beings have been scientifically examined by several researchers with *no* evidence emerging to validate those claims.

As I mentioned before, anything uncanny at first appears to have something supernatural about it. However, a scientific study reveals that the system in question is after all behaving according to the known laws of science. A piece of paper changes colour from red to blue and vice versa if it is dipped in certain fluids. Why ? The mystery disappears when we know that the paper in question is litmus paper and the fluids are bases and acids. A magician produces rabbit out of a hat. Has he violated the law of conservation of matter ? No ! He can be persuaded to reveal the sleight of hand in his 'trick'. Controlled experiments revealed that there was nothing exceptional about the spoon-bending performances of Yuri Geller. Even the sensational claims about the 'mysteries' of the Bermuda Triangle have been blown apart by scientific investigations.

Nevertheless as long as man wants to believe that anything uncanny is supernatural or divine, there will be unscrupulous persons to take advantage of that attitude. The attitude will go away only through continued exposure to science and the scientific method. The illusory miracles of the so called holy men will not cease to be effective until man appreciates the concrete miracles of science and technology.

Concluding Remarks

By way of summarizing all I have said, I can do no better than refer you to the tale of Alladin and the Magic Lamp, from the Arabian Nights. To us, the Alladins of the twentieth century, science is the magic lamp and technology the genie at its command. Are we mature enough to use the lamp ? Not yet ! If we make conscious efforts to understand the significance of the lamp and what its genie is capable of, we would be able to employ it for our betterment.

As Jawaharlal Nehru put it in the context of India :

"Science alone can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people...".

If, on the other hand, we do not bother to understand science and technology, and use them indiscriminately, they have it in their power to destroy us.

What course are we going to take ?

PROF. JAYANT V. NARLIKAR - BIODATA

Prof. J.V. Narlikar, Professor of Theoretical Astrophysics Group at Tata Institute of Fundamental Research, Bombay, belongs to the younger, post-independence generation of Indian scientists, who have received international recognition and eminence. Prof. Narlikar belongs to a family of mathematicians and it is no wonder that mathematics is in his blood.

Prof. Narlikar graduated from Banaras Hindu University where his father V.V. Narlikar was the Professor of mathematics. He pursued his post graduate studies at Cambridge and received his doctorate in 1963. In 1976, he was awarded Sc.D. (Cantab.) degree for distinguished research. He also won Smith's Prize (1962) and the Alams Prize (1967) of the University of Cambridge.

Prof. Narlikar's early work with Hoyle was on the Steady State Theory of the Universe. This work provided, for the first time, a working theory for continuous creation of matter within the frame work of Einstein's General Relativity Theory. Hoyle and Narlikar also gave a complete description of electrodynamics at the quantum as well as the classical level, using the concept of a new theory of gravity which is now known as the Conformal Theory of Gravity. Back in India at the Tata Institute of Fundamental Research, Prof. Narlikar has continued his work on Cosmology and Astrophysics.

Professor Narlikar was elected fellow of the Indian Academy of Sciences in 1974 and of the Indian National Science Academy in 1977. He is a fellow of the Royal Astronomical Society, London, and also of the Cambridge Philosophical Society. He is a member of the Indian Physics Association and the Astronomical Society of India. Prof. Narlikar was awarded the Golden Jubilee Gold Medal by the Institute of Sciences, Bombay, in 1973 and got the coveted S.S. Bhatnagar Award for physical sciences in 1978. He is also a recipient of Padmabhushan Award in 1965.

Professor Narlikar has delivered a series of Lectures during the last decade. Notable among them are Lokamanya Tilak Memorial Lecture at Poona University (1967), Jawaharlal Nehru Memorial Lecture at New Delhi (1976), Vikram Sarabhai Memorial Lecture at Bombay (1977), Visvesvaraya Memorial Lecture at Pune (1977). He is also a visiting Professor to a number of Foreign and Indian Universities, including the California Institute of Technology, University of Maryland, Cornell, Texas at Austin and California at San Diego.

PREVIOUS FOUNDER MEMORIAL LECTURES

1965 :	Standardization	: Dr. Lal C. Verman
1966 :	India's Potential in Minerals and Metals	: Dr. D. N. Wadia
1967 :	Education, Science and Development	: Dr. D. S. Kothari
1968 :	Research and Indian Industry	: Dr. G. P. Kane
1969 :	Value of Scientific Research	: Prof. T. R. Seshadri
1970 :	Science and India's Future	: Dr. S. Bhagavantam
1971 :	The Frontiers of Astrophysics	: Prof. M.G.K. Menon
1972 :	Converting a Scientific Break-through in Agriculture into a Production Advance	: Dr. M. S. Swaminathan
1973 :	Developing Patterns of Industrial R & D Culture	: Dr. Y. Nayudamma
1974 :	Science and Technology in Relation to Indian Needs and Resources	: Dr. S. Varadarajan
1975 :	On Some New Possibilities of the Peaceful Uses of Atomic Energy	: Dr. R. Ramanna
1976 :	Research, Development and Engineering Associated with Renewable Energy Resources	: Dr. A. Ramachandran
1977 :	Nutrition and Public Health—The Current Indian Scene	: Dr. C. Gopalan
1978 :	Science, Technology and Society	: Dr. Atma Ram
1979 :	Impact of Nuclear Research on the Future Technology of Nuclear Power	: Dr. P. K. Iyengar
1980 :	Alcohols as Fuels and Chemical Feedstocks	: Dr. Donald F, Othmer
1981 :	The Environmental Imperatives of Development	: Dr. B. P. Pal