

The Science-Society Interaction

Jayant Vishnu Narlikar

Inter-University centre for Astronomy and Astrophysics, Pune

Introduction:

It is often stated that we live in the age of science: that science and technology are shaping our very existence. No one described the impact of science and technology (S&T in brief) more graphically than Alvin Toffler in his book 'The Future Shock'. I summarize in my own words his description of the way science and technology have come increasingly to determine the conditions under which we live and why this circumstance has come like something of a shock to human societies the world over.

Let us do some elementary arithmetic! Divide the last 50,000 years or so of known human existence on this planet into some 800 human life spans- each life span comprising of 62.5 years. Take this life span which is typical of that of a human being, as a representative unit of time. Of these 800 time units, for which some historical information is available, the first 650 or so were spent by man in primitive conditions living in caves. The art of writing is not more than 70 life spans old and that of printing only 6 life spans old. The electric motor is two life spans old. In fact most of the things we use in our daily existence involve technology much younger, some of it not more than one life span old. The discovery of atomic energy, use of space technology and the proliferation of computers are all less than a life span old.

This indicates how rapidly scientific ideas are being translated into technological inventions and how rapidly we are having to assimilate them in our lives. Yet the rapidity with which this is taking place is not proving entirely beneficial to the society. Rather, the situation resembles that of a human being invited to a buffet dinner where he or she is confronted with a feast of excellent eatables served in rapid succession and tempted to eat them as fast as they come. The banquet may look dazzling but the diner ought to pick and choose keeping in mind the limitations of health and capacity to digest. This the human society has not yet learnt to do.

The diner in the above example may ask: 'How do I know what is good for me- how much of it is good for me - and what items I should avoid?' Who is to tell him? In the case of citizen of the twentyfirst century, this need for advice can be satisfied by a proper society-science interaction. Science communication in various forms can help inform the citizen about what is happening in S&T, while the development of the scientific temper can help shape the individual's attitude towards this information.

Science communication :

Information holds the key towards facing the future shock. Whenever new discoveries in technology take place, it is necessary to understand their full implications. Very often a technology is announced but the science it is based on is not so well publicized. Even leaders in the field sometimes fail to grasp the potential of a discovery. There are famous examples. Thomas Alva Edison, the great inventor, did not believe that alternating currents would play any useful role. Lord Rutherford, who discovered that the composition of an atomic nucleus can be probed and transmuted, did not believe that the discovery had a practical implication. Within three decades, the discovery was put to the highly destructive use in the form of a nuclear holocaust, as well as to peaceful use as an atomic reactor for generating energy. Many distinguished scientists believed after the early rocket experiments that space technology will not play any important role.

Examples like these suggest that there needs to be a lot of public discussion between scientists and leaders, decision makers in the society, whenever any new scientific discovery takes place or is in the offing. What are the future implications of the discovery? Is it likely to be harmful to the society? Does it need to be channeled in a certain direction? In the physical science nuclear studies have already shown us, perhaps too late, why one needs to exercise control on the direction of research. The technique enabling the knowledge of the sex of the child still to be born had to be restricted because of its misuse. Evidently these are situations where in scientists have to come down from their labs or studies to talk practical matters with the society.

Science communication is therefore extremely important today, much more so than appreciated by the common man today. Not only do the scientists need to come out to communicate, there can be a whole class of communicators who are basically good at communication and who read scientific literature or consult with the experts and then tell what they learnt to others. It is possible today to use different media for science communication, including radio, TV, internet, lecturing, movies, etc. A number of voluntary organisations have come up to pursue this objective. But much more needs to be done.

India has a number of such organizations, national as well as in states and towns. The Government of India has supported such activities through vigyan prasar which is under the umbrella of the Department of Science and Technology. There is a National Centre for Science Communicators, headquartered in Mumbai which played a very active role in the nucleation of the International Union of Science Communicators. I am happy to say that the IUSC was recently established with headquarters in Mumbai.

Science journalism:

An important arm of science communication is science journalism. It is sadly much neglected in India. Reporting of scientific events takes up very small percentage of available newspaper space. Very often a science news item is simply taken over from foreign sources, 'by arrangement'. Clearly science is not a priority subject in the minds of newspaper producers or editors.

Investigative journalism these days covers many cases of corruption, crime, spying, conspiracy and war stories. Once in a while, the scientific world too offers challenging and highly interesting cases. In a typical case, a claim to an important discovery is made but without proper substantiation. In some situations the result is based on fraud while in others it is genuine mistake. There are also instances of scientific plagiarism. In case it is said "Good news is no news": perhaps the journalists may at least cover these examples of malpractice in science ! I may give classic example from the past.

In 1903 the eminent French physicist R. Blondlot claimed to have discovered a new type of radiation called N-rays (N for the town Nancy where the discovery was supposedly made) Coming shortly after the discovery of X-rays in the Germany, this discovery of new rays with remarkable properties was hailed widely in France partly because of the competition between the two neighbouring countries in many fields including science. The N-rays became fashionable and a large number of research papers on them began to appear in French journals. Soon Blondlot was awarded the prestigious Lalande prizes by the French Academy for this discovery.

However, a scientific experiment is nothing if not repeatable. This was not happening in case of N-rays. The rays could not be detected in similar experiments in England or Germany. What was wrong ? To find out the British scientists requested R.W. Wood, a distinguished American scientist to visit Blondlot's laboratory and inspect the experiment. (A scientist from a rival country like Britain or Germany would not have been welcome in France.) Wood made the trip and found that the claim for N-rays was totally false. His own account of how he detected this fraud makes a very interesting reading even for the layman today.

The temptation to make spectacular but fraudulent claims comes more strongly in the present time than in the relatively placid times a century ago. This is because a scientist is judged by this performance much more stringently today than in the last century. Awards, peer support, promotion, project grants are all linked with performance. Thus if Mr. X has made a stupendous discovery he stands to attract a lot of financial support as well as wield power in the scientific circles. So there is a strong temptation for him to rush out and make premature announcements. In spite of these temptations science has remained relatively clean mainly because a scientific fraud is detected sooner than later. However, such cases as do turn up from time to time need to be widely reported to the public.

Another related area where investigative journalism can do a lot is in testing the claims of UFOs as extra-terrestrial spacecrafts. The so-called unidentified flying objects are reported in the press from time to time. The common man gets excited by the suggestion that these are spaceships from some alien civilization beyond our Earth. The real explanations may be quite mundane: the object may be Venus, or an optical illusion (Like a mirage) or a man-made spy satellite, or simply the figment of a highly fertile imagination.

Philip Klass, a journalist from Washington DC has written a book entitled 'UFOs Explained' in which he has given absorbing details of investigative journalism which removed the mystery around several such claims. He has also shown how the so-called photographic evidence can be faked. Indeed, in some cases the UFO sighting has been turned (fraudulently) to material gains.

Another set of events which generated considerable excitement around twenty five years ago related to the apparently strange events occurring in the so-called 'Bermuda Triangle'. These were debunked by science journalism, although in India they still exist in popular imagination.

Speaking in this vein, there is another topic which offers great scope to a science journalist in India. I will return to it shortly. I now turn to consider the scientific temper.

The scientific temper :

A few years ago I attended an international and inter-disciplinary conference dealing with the issues man has to face in the twenty-first century. Naturally issues such as global environment, population control, food-availability, communications, education, science and technology, etc., featured prominently. As speakers after speaker covered a variety of topics of great relevance to the theme of the conference, I increasingly began to feel like a diner at a sumptuous meal searching desperately for that tiny but vital item, viz, the salt shaker. That pinch of salt, is the scientific temper that is such an essential component of man's mental framework in his struggles to face the challenges of the present and the future.

What is scientific temper? Why is its relevance being felt now rather than in the past? Is it an individual trait or does it also extend to societies, cultures civilizations? To what extent is it prevalent today? what can be done to make it more widespread? There are the questions I shall try to answer. But the bottom line has been stated much more effectively by Pandit Jawaharlal Nehru:

.....The impact of science and the modern have brought a greater appreciation of facts, a more critical faculty, a weighing of evidence, a refusal to accept tradition merely because it is tradition....

But even today it is strange how we suddenly became overwhelmed by tradition, and the critical faculties of even intelligent men cease to function..... Only when we are politically and economically free will the mind function normally and critically.

..... (Discovery of India)

This was written during the British Raj. Today we live in a free India which is feeling its way towards economic prosperity. Yet we are still a long way away from achieving that scientific outlook which Nehru considered so essential for our future well-being. To appreciate what the scientific outlook is all about, let us first see how science itself works.

There are three steps in the progressive march of science: experiment and observation/ theoretical interpretation/ prediction of new results. This sequence is endless. One performs experiments in the laboratory, or observes some natural phenomenon and then tries to interpret it in terms of a theoretical framework. If the attempt succeeds, then one tries to make new predictions that future experiments or observations will verify. If the success of the theory continues, one keeps believing in the theory. However, one never accords the theory a blank cheque for being correct. There is always a possibility that a future experiment may disagree with the predictions of the theory, in which case it may have to be abandoned or modified or replaced by a new and better theoretical framework. Thus Newton's law of gravitation continued successfully until some sophisticated test in the solar system showed its inadequacies and it was replaced by Einstein's theory of relativity. It was in this connection that Sir Herman Bondi, the well-known astronomer, remarked :

.... The essential thing in science is for the scientist to think up a theory. There is no way of mechanizing this process; there is no way of breaking it down into a science factory. It always requires human imagination, and indeed in science we pay the highest respect to creativity, to originality. It is, of course clear that since every theory must live dangerously, the casualty rate is pretty high. So we do not honour scientist for being right; It is never given to anybody to be always right. We honour scientist for being original, for being stimulating, for having started a whole line of work. Science is the most human of endeavours because it depends on co-operation, it depends on co-operation, it depends on people testing each other's work and it depends on people taking notice of each other.

(Cosmology Now, ed L.John, 1973, B.B.C publications)

Bondi's comment needs one clarification. It does not mean that any Tom, Dick or Harry can propose 'new ideas, claiming to be better than Newton or Einstein. I get such ideas from dozens of people in the post, which are vague flights of imagination with no backing of quantitative facts. Bondi here means ideas carefully worked out with rigorous mathematics and having the benefit of confirmation by physical facts. In fact there is no simple way to the truth, whatever it may be. One needs patience in putting together whatever understanding of nature our society has acquired and build on it towards a greater understanding.

The scientific outlook has evolved from this practice of science: it relies on factual evidence and statements that can be checked against established truth. It allows for pragmatism, that is willingness to drop a paradigm if it fails the test of facts and to adopt a better one if it meets all factual checks. However, the scientific outlook need not be the prerogative of the scientist alone. After all, it owes its origin to human curiosity about Nature and as such every one of us, whether a scientist, or not, is entitled to it. Indeed, just as in the case of science, progress could be achieved only when the scientific outlook prevailed over innate conservatism, so in the case of society of human beings this outlook acts as an antidote to the evils of prejudice and superstitions.

Science and Superstitions:

Superstitions are born out of ignorance of how Nature functions. Science is dedicated to the unraveling of the mysteries of nature. As one particular mystery is solved, we should expect the superstitions based on it to disappear. Yet, this does not always happen in practice because of the lack of scientific outlook in the typical human being. I give below one example.

The early human societies ascribed occult powers to planets. This assumption arose from ignorance of what planets are and how they move. Now that astronomy has answered all of the questions raised about planets by the primitive man, we should expect this assumption to be regarded as groundless. Yet this has not happened. Even in the technologically advanced countries this belief persists among sections of educated classes. In the mid -1970s a group of leading scientists including several Nobel Laureates in the West signed a circular denouncing the very basis of this belief. I give below an extract from their statement:

.....It is simply a mistake to imagine that the forces exerted by stars and planets at the moment of birth can in any way shape our futures. Neither is it true that the positions of distant heavenly bodies make certain days or periods more favourable to particular kinds of action, or that the sign under which one was born determines one's compatibility or incompatibility with other people.... In these uncertain times many long for the comfort of having guidance in making decisions. They would like to believe in a destiny predetermined by astral forces beyond their control. However, we must all face the world, and we must realize that our futures lie in ourselves, and not in the stars....

(The Humanist, Sept./Oct. 1975).

Do planets influence human destiny? The subject of astrology is based on the answer to this question being 'yes'. How will a scientist go about testing the hypothesis that the answer is 'yes?' He will not be satisfied by the prediction by a single person based on a single horoscope. First he will require a set of well-defined rules on which such predictions are based. The rules should be unambiguous so that different persons make the same prediction from the same horoscope. Next he will need to be convinced that these rules work in a statistically significant manner to discount the possibility of the prediction being right purely by chance. This will require a systematic study of a large number of such trials under different conditions.

Likewise, tests have to be made of the above hypothesis about planets. It is necessary to cast the prediction in a well-focussed form where it can be tested. Such tests as have been conducted so far by scientists have yielded negative results. But again, it is not always necessary to call upon a professional scientist to perform such tests. The educated common man can

himself sift the evidence provided he adopts an objective outlook. Let me give one illustrative example of experiments of this kind conducted in the United States to test the scientific predictivity of astrology.

A comprehensive test was conducted by Bernie Silverman who sampled the marriage and divorce rates in Michigan in 1967 and 1968. His sample was large, 2978 marriages and 478 divorces. The birth charts of the couples involved were examined by astrologers who were asked to opine on whether the horoscopes matched sufficiently to warrant the conclusion that the couple's marriage would be long lasting and happy. The astrologers (using whatever criteria they had) made out two lots, one with matching and the other with conflicting horoscopes: those in the former category would have a stable and happy marriage whereas those in the latter wouldn't. These 'prediction' were then compared with the actual state of marriages of these couples, some of whom, as stated earlier, were happily married while others had divorces, broken marriages, etc. It was then a simple matter to test the argument between the actual and the predicted classifications of the sample. Rigorous statistical analyses demonstrated that there was no correlation between predictions and the actual results.

I could go on with other examples, to illustrate that astrology has been tested for the scientific criterion of predictability in numerous ways by numerous research workers on numerous occasions- and has always been found wanting.

Individually or as part of a larger group man has always lived by certain traditional beliefs. These beliefs are inextricably mixed with his cultural and religious heritage. Inevitably conflicts arise whenever the critical appraisal inherent in the scientific temper is applied to these beliefs. Some conflicts arise because the beliefs or the rituals they imply had a rational basis in the olden days but which they no longer possess today. Some rituals may have had a symbolic or even a practical meaning in the social ambience of several centuries ago; today they have become irrelevant. The question arises: what should one do in case such as a conflict arises.

On the 'traditional' side we have the traditional virtues of the individual's responsibility to the society, the society's commitment to ensure the well being of its members and the individual and social commitment to preserve the natural habitat around us. Armed with these virtues man can assess what science has to offer: he can take judicious decision on what to accept and what to reject. This is where the scientific temper comes to the help of the society as a whole.

The technologically advanced nations of the West have been experiencing the ill effects of uncontrolled impact of science and technology on the society. The destructive nuclear arsenal, the excessive industrial pollution, the enforced idleness brought about by automation and the consequent psychological problems of mechanization, etc., are there to see. Does this mean that we must put a stop to all scientific and technological development? Such a response, already advocated by a few in the developing nations, indicates a panic reaction. Given the traditional virtues mentioned above as guiding principles it should be possible to identify a rational path that skirts around the above pitfalls.

The present status :

Let me review briefly how we Indians stand today vis-a-vis Nehru's expectation that
"..... Only when we are politically and economically free will the mind function normally and critically".

A dispassionate survey presents a somewhat mixed picture.

On the one hand, as I had mentioned earlier, we have several NGOs devoting their efforts to spreading rationalism and no eradicating superstitions. There are organizations which conduct public awareness programmes through lecture demonstrations, street plays, experiments debunking the so-called miracles, articles and books on the importance of the scientific temper, and so on. The National council for science and Technology Communication (NCSTC) in New Delhi has been supporting such programmes in an imaginative fashion.

The NCSTC had been responsible for launching the National Science Day to be celebrated on February 28, commemorating the discovery (on that date in 1928) by C.V Raman that fetched him the Nobel prize in physics. On this day, (and indeed in the week covering that date) there are several awareness programmes throughout the country. Scientific institutions keep an open house for the general public, with audio-visuals on their work, exhibition and lectures, etc. Some institutions organize special quiz programmes and competitions and for schoolchildren.

While there are several such efforts in an organized manner both in and out of the government, what is the mindset of the 'person in the street'? Can we confidently assert that in the half century since independence, we have made a significant dent in the wall of superstitions that have steadily thickened over the centuries? We remember, for example, the great social reformer Raja Ram Mohan Roy and his crusade against the Suttie-ritual. But there take place isolated incidents of this ritual and they attract crowds of believers.

Nor is superstition confined to villages only. The episode of the idols of Lord Ganesha drinking milk drew large crowds in Delhi, Mumbai and other cities in India with some ministers also expressing their wonder and joy at the sight. It did not take long to debunk the phenomenon in terms of known science, but the spontaneity of beliefs was a give-away that the veneer of science or technology on the society is very thin indeed.

But perhaps of greater concern is the rising trend towards superstitions. Several symptoms can be cited of this trend.

1. More marriages are being decided by the criterion of matching of horoscopes than a generation ago. Thus I know of parents whose marriages were not passed through the 'horoscope filter', but whose children feel it necessary to apply this criterion for their marriage.
2. With new technology, new superstitions are getting hold of the society. A recent rage is vastushastra and its Chinese counterpart,

the Feng Shui. Influential politicians and leaders of society have been swayed by this cult. None of the claims of these subjects have passed scientific scrutiny.

3. Despite debunking of Godmen's miracles by science, a large section even of the educated urbanites continues to believe in the Baba's who demonstrate their superhuman powers through miracles. In fact this is an area where science journalism could bring its investigative aspects to bear. So far it has registered moderate success but much more needs to be done.

4. The legitimisation of astrology as a 'science' by the University Grants Commission is another symptom of this unfortunate trend. The UGC used the word 'Vedic Astrology' implying that the subject is of Vedic origin. All historical evidence, however, shows that planetary astrology using horoscopes came from the west, from Greece, Babylone etc.

Miracles of science benefit all:

One could easily enlarge this list. Granted, there are problems with excessive reliance on automation, the dangers of pollution with indiscriminate uses of technology, there may be serious dangers for the society from continuing certain areas of scientific research, but this does not mean that we turn away from the scientific path and regasp the age-old superstitions which have been proven to be invalid.

Indeed, at first sight these problems before us appear to be formidable if not insurmountable. yet, we have only to look at the remarkable progress of science over the last few decades to see that a properly channelled scientific approach holds out hope for the future. The achievements of space technology with such highlights as the manned trips to the Moon, the landing on Mars and the SITE programme in our country, the rapid growth of communications which has dramatically brought the far corners near, the advances in medicine, biology, agriculture-are they not scientific miracles happening before our own eyes and achieved during less than the span of a generation? Unlike the so-called miracles of the so-called godmen, *the miracles of science benefit not one single individual, but a whole class of humanity*. They benefit the poor as well as the rich. the invention of electric power not only runs the gadgets of the rich, it also provides light to the remote villages.

The developed nations have recognized these facts and they not only support science in general but also continue to encourage basic research, which at first may appear 'useless' but may lead to useful applications like those just mentioned. For us to ignore basic research at this stage would mean that we will have to keep on importing new ideas from abroad. This would be contrary to our policy of self-reliance. India has plenty of talent for basic research, most of which is untapped. Suitable support for basic research will unearth this talent and bring in its own rewards in the long term if not immediately. Right now I can think of one analogy to illustrate my point of view. Imagine a country which has vast untapped resources of oil, but which will not search for these for reasons of heavy financial outlay. Such a country will forever be dependent on oil imported from abroad. And, finally let me emphasize that basic research does not require heavy financial outlay when compared to its rich potential. We must, however, ensure with adequate safeguards that the research produced is of first class quality.

When Lord Krishna finished telling the Gita to Arjuna, he ended by saying: "**Reflect over what I have said, fully and then do what you wish,**" In a sense this is what the scientific temper calls upon us to do: to weigh in all the evidence and then decide what is best. I am confident that if, and only if, we are not blinded by traditions and dazzled by science but keep our visors open and our minds alert, our country will make a triumphant march towards progress in this century.

THE VIEWPOINT

SCIENTIFIC AWARENESS ABOUT NATURAL DISASTERS

Meenakshi

Ex- students (M.Sc geology)

D.B.S (P.G.) College, Dehradun- 248001

Disasters are sudden and unanticipated events and occur in varied forms. Some are annual phenomena, seasonal and others are very unpredictable. If an unprecedented event has occurred once and chances are that it would arise again, then it would be necessary to take ample measures to prevent its occurrence or at least minimize the losses. Although various attempts are made to minimize the ill-effects of disasters. However, there has not been any decrease in the damage incurred. This shows that there is an urge of scientific base to monitor and forecast these events before their occurrence. India has so far seen various faces of disasters sometimes in the form of earthquakes, Landslides or sometimes floods, droughts and cyclones, contribute towards nothing but, the loss of life, loss of properties.

The term "disaster" is used in the wrong way, as it does not come with the intention of destructions. Rather these are the natural and normal processes and they are bound to come in a cyclic order. It becomes disastrous due to the lack of knowledge to cope with their consequences. To overcome this, we need a platform DISASTER MANAGEMENT, which enables a total and effective response to offset its harmful effects.

To cope with all these, we require substantial forecasting methodology. Accurate information requires collection of relevant data on various agency, processed to evolve a forecast and Management Planning the requires setting up a national agency for monitoring geophysical changes indicative of occurrence of hazards, preparation of hazard zoning maps and their publication and dissemination of information, to educate the public.