

## MEETING REPORTS

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known experts in the field, as panel members. The panelists presented their views on the important results and future outlook. There was clear consensus on many leading issues and at the same time significant divergence of views on some others. The most notable disagreement perhaps, is on the inter-relationship between convection, substorms and storms, in particular the key role of magnetospheric convection to storm development. Some felt that substorms are not essential to storm development but are merely incidental. There were, however, other strong

views that storms and substorms influence each other, especially considering the closeness of the locations where both of them originate and the efficient electrodynamic coupling among the different regions of the magnetosphere. The participants called for concerted efforts to determine the role of oxygen ions and wave-particle interactions on the ring current decay for a better understanding of the recovery phase of the geomagnetic storms. On space weather related issues, the evaluation of the performances of the current prediction techniques with high forecasting ability,

such as those based on neural network, nonlinear dynamics, etc. was recommended.

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## IN CONVERSATION

# An interview with Murli Manohar Joshi, Minister for Human Resource Development, Science and Technology and Ocean Development

An academic and a politician, Murli Manohar Joshi, retired Professor of Physics at Allahabad University, holds a unique position to fashion India's Science and Technology (S&T) policy for the future. Specialized in spectroscopy, he has authored nearly 100 research articles and a similar number of articles of general interest. He is a keen advocate for 'application of S&T as an equal-opportunity developmental strategy for all' in India.

Following are excerpts from an interview with the minister, held on 28 June 2001.

### S&T in India and sustainable consumption

*India is a developing country. India aspires to be counted on as a developed nation, though strictly neither third world nor first world. Also, India could have a population of about 1.7 billion people within the lifetime of our children. So, under your leadership, can India, having a cross-section of both ultrahigh technology sectors and the poorest of the poor, look forward to a S&T policy that is unique to our requirements. Do you feel the need for a*

*creative, unique S&T policy and not a 'copy-cat agenda'?*

On the extent of my conceptualization of sustainable consumption, the latest example was the announcement of 'Simputer'. The Simputer combines two things; firstly, science in the service of the common man and secondly, making it affordable and available to the poor. What I am saying about sustainable consumption is that we should look to the poor as a market, rather than the rich. When you make unsustainable consumption or high-rise consumption, then you are primarily looking to the market of the rich people, the rich who can afford, who have surplus money and, who can purchase whatever goods are presented to them. My idea is, development, – 'yes', S&T, – 'yes'; but it must be used in the service of the common man. An example is of the Simputer, which is very affordable and it works for the common man, even for the illiterate. There are also differences, based on the concept that if it is a developing nation the fee (license fee) would be very small, while for a developed nation the fee would be very high. So, we are addressing the association of S&T with different layers of society in

a manner that those who can afford, get more, and those who cannot, get helped. In this way, an attempt is to create a scientific egalitarian society, a society that is both scientific and egalitarian, where technology is within the reach of everyone.

*With reference to your speech delivered on 11 May 2000 entitled 'Sustainable consumption: A new paradigm', would your vision for the future (of S&T) integrate sustainable consumption into the basic weave and fabric of our society?*

Now, the Planning Commission has formed a Committee on Sustainable Consumption with R. A. Mashelkar as the Chairman. This is the approach which is now being taken by a very large number of scientists. Last year, some eighty scientists from eighty countries gathered in Tokyo and discussed sustainable consumption. Scientists have now started adopting it. In biotechnology, I have been focusing on this for the past three years that we work on diseases primarily affecting the masses, such as malaria, kala azar, TB and also HIV. Again, giving more nutrition to the poor by introducing

genetic modifications in maize or in potato, the common man's diet. That is how we are trying to introduce S&T for the service of the common man and sustainable consumption, i.e. the consumption that you can sustain for a very large number of people, if possible for the entire country.

You will also notice that our attempt is now to even promote an innovator who is otherwise not qualified – the grass-roots innovator. We have invited them to come forward and we will help them towards commercialization of the inventions. This is all what we are trying to do, incorporating these as pilot projects, based on which we would formulate a policy framework where all these elements would find a very fair place.

Those who are working in the pharmaceutical industry should try and find out certain drugs which are for the common man or the poor man; the idea is therefore to share our (scientists) knowledge with the society. We must try to improve their quality of life through the application of S&T. I should also say that Technology Development Board (TDB), Technology Information Forecasting Assessment Council (TIFAC), etc. reflect our attempts, as a sector-wise approach. Also, in CSIR various labs are working in this direction. Here is an example of what the Central Leather Research Institute (CLRI), Chennai has done. Till now, chrome leather or soft leather was very costly, since it was produced from the hide of slaughtered animals. But there are a large number of dead animals (carcass), whose leather is hard and cannot be used. We (scientists) found that this leather can be softened and can be raised to the same quality as that of chrome leather. Perhaps, we would be serving two purposes; firstly, in tackling the problem of unclaimed carcass and secondly, providing cheap leather to the leather factories. Some 80,000 persons of Kolhapur, Maharashtra, who would have been otherwise out of job have now again become productive through this technology.

This technology is what we are trying to spread and it will find a place in the formulation of our sustainable consumption policy where the Planning Commission will look specifically at how it can be integrated with animal husbandry and development of breeds,

development of cow and other animal sheds, where old animals can be kept and allowed to die and then the carcass can be utilized. These animals that are moving here and there, wasting themselves and producing all sorts of diseases, when they die can now all be brought to such centres.

Now, let us come to another part of sustainable consumption, for example, in the case of climatic change. Most of climatic changes arise from the excessive use of energy by certain nations. Here we are trying to argue, 'Look here, if you continue with increased levels of consumption, the resulting climatic changes will affect everybody in the world'. It not only affects coastal areas (directly) when the temperature rises, but will also affect life and health of people everywhere, sooner or later. Therefore, we must now examine how much global warming this planet can afford, beyond sustainable consumption. Since we are emphasizing this, please have a second look; change your use of energy sources. Use energy, but do not produce excess of greenhouse gases. Otherwise the results will affect a very large section of the world population. What I am trying to say is this: S&T, 'yes', development, 'yes'. But one must determine how much development and its rate. Not only must the rate of growth be determined, but also the patterns of consumption. Today, we have only a Chief Executive Officer, tomorrow we might like to have a Chief Environmental Officer, as part of industrial management, changing the overall perspective. Again in estimation of 'costs' today, we take into account the cost of raw material, machinery, depreciation, salary and wages, etc. but do not take into account the 'social cost'. This will create a change in the evaluation of the costs, profits, and then the deployment of the profits.

*Is a new S&T policy statement in the making? I believe it is long overdue*

This is a complex issue. S&T policy of any country today cannot be sustained in isolation. It has to keep a very cautious watch on what is happening all around. And then for our country what kind of S&T policy would on one hand, lead to economic growth and on the other develop our own talents and skills, and how far this (S&T) policy

would suit local conditions? While science is universal, technology is local. This will take some time, as there is a mindset in people even today that S&T policy should be only some sort of adoption of what is happening elsewhere. This has not yielded desired results.

I will give you an example. A couple of months ago when I was in the National Environmental Engineering Research Institute (NEERI), a young student wanted to show me how to purify water using clove extract which has sufficient bactericidal properties. Everybody knows this in India. For toothaches, etc. application of clove keeps the dental framework free from all sorts of bacteria. The student had read about the uses of clove in traditional literature as well as about various herbs which turn brackish, saltish or foul-smelling water potable. This is an instance where a local specific technology is available. You need not use highly sophisticated purification plants in a village. Simple, locally available materials can do the job. Only in the case of purifying large bodies of water, one might need to take help of modern technology. My point therefore is that there is always a case of using local specific technology and upgrading it.

Water harvesting is one such technology that was prevailing in the country for several centuries, but we have not used it. We must use it in conjunction with modern knowledge (of weather forecasting). The basic principle of water harvesting leads to sustainable consumption. My efforts would be to give more emphasis on so-called non-conventional sources of energy, particularly solar and bioenergy. Both these can be successfully used in our country. So I have been asking my scientist friends and also the Planning Commission to look into this problem.

Here we are importing crude, i.e. our energy import bill is about Rs 80,000 crores per year. Even if we can reduce it by Rs 20,000 crores, this is Rs 20,000 crores of foreign exchange saved. So, instead of increasing our import budget every year can we not give some money for research in solar, bioenergy and wind energy and thereby gradually decrease our dependence on external imports? Only initial (capital) cost will be there, and raw material is almost free and in abundance. So these are the ideas

we are trying to collate, generate. Please look at these problems, these our own problems. Nutrition, we need nutrition, cheap nutrition. I am talking to the scientists – please have a very quick look on nutrition. Immunization is again important for us. Also, we have to see how our S&T can help other developing nations.

*So when can we expect the policy?*

The S&T policy is in the final stage of drafting. At this stage there is need for discussion. It only requires to be properly worded. It cannot be very long or very short. We are discussing what should be the first priority, the second etc., and how to match it with our planning resources. If I make a policy which has no match to resources, it can be a wonderful policy but it will be ineffective. We have to also come in contact with the industry and interact with it for the technology part.

*(The question is asked again)*

Anytime, I will see. This is the time when most of my scientists are abroad in June, July – attending meetings and conferences. We have to consult many of them, after all, there is the question of fundamental research work and technology – applied and basic research. Such as in what percentage, in which institution, and in what manner. Can we have certain very specific scientific institutions which have a very special position in our set-up? Can we delink many of them from the rut of the bureaucratic system?

**On interface between industry, R&D institutions and academia for S&T**

*There are presently several weak links in the interface (one being of translating the acquired technology to meet the specific needs of customers) between industry, R&D institutions and academia. How do you propose to strengthen the hand-shake?*

I have for the last 3–4 years designed a small mechanism whereby the S&T departments, academia, industry and HRD can interact. Even while I was at Allahabad University, I was saying that academia, S&T units and bureaucracy (in those days industry had a very small role unlike now) must interact. There should be frequent exchange between

these four sectors. Academicians should come to S&T labs; mobility should be there. People from the S&T labs, academia and even industry can come to bureaucracy. A Secretary from bureaucracy can go to a teaching institution and teach at a university for a year or so, come in contact with younger minds, read the latest literature and come back enlightened. Similarly, a teacher could take up bureaucracy. These are ideas which I want to try out in this country. It is about time. There are very good technocrats in industry who can be asked to teach in universities or work in the labs. This way, what the labs and academia lack, will be known to them. They will complement each other. We have a committee here in the department of HRD which meets occasionally and discusses issues of mutual interaction, of each other's needs and what part each one of us can play.

**On Ocean Development**

*Ocean Development has not got the necessary impetus so far. As Minister also for Ocean Development, can we see and hope for a change in this 'second-best' approach to the oceans? In essence what is going to be India's vision/mission for Ocean Development?*

I have asked the Secretary (Harsh Gupta) to prepare a document for an Ocean Commission just like, for example, the Atomic Energy Commission and the Space Commission. It is very important for India to have a very strong Ocean Department. We will try to present it in the Tenth Plan, since the Secretary has just taken over. In government things do not move....

*Staying with oceans and the recent finds at the Gulf of Cambay. Do you think it will be excavated?*

Yes, we have asked for a plan to be prepared in consultation with the archaeological department and experts in marine archaeology, so that we can go ahead. We need inputs from the space department, marine archaeology, etc. This is a subject, which was never attended to in this country.

*Would you consider asking for foreign help, as was done in Egypt for a similar purpose?*

That depends upon the experts' advice.

**On S&T research funding and building infrastructure**

*What about thrust on University research?*

This is a very badly neglected area.

*Are you going to do something about it?*

Yes, yes, yes. The greatest damage was done when research was totally usurped by government labs.

*Today, infrastructure in S&T is suffering with ageing instrumentation or the lack of high quality infrastructure in the Universities. What is your view?*

Yes, infrastructure is very poor. When I was a research student, I was a CSIR fellow, working in the University. Today, it is difficult for a CSIR fellow to work in all Universities. There will only be selected Universities where they can work; they will seek this lab or that lab. This is not a happy situation. This is an alarming situation. I have been asking both the research labs and the industry to fund research in the Universities. In the beginning they may select some universities, which have at least minimal infrastructure.

*Can the general level of infrastructure in all universities be raised?*

Yes, to a much higher level. For that I have asked the UGC to identify Universities from various parts of the country. It should not be clustered in a particular area but fairly well dispersed.

*There is the FIST programme*

That is a limited programme. You select certain departments and FIST has limited funds.

*The amount of money given in this year's budget (for FIST) is pretty low*

Last year's money was not used (laughs). Use it. There will be no difficulty in getting supplementary funds.

*Extra-mural research funding at present estimates is about Rs 250 crores. There is an estimated need to double the grants for sponsored research. Do you want to comment on this?*

It is always desirable to have more funds for sponsored research. In technology, if the research is not sponsored, then one does not know its commercial value. It must come from the industry, mostly.

*The Prime Minister, in his inaugural address at the Indian Science Congress of 3 January 2001, stated that the government would hike investments in the R&D sector to 2% of GDP from its present level of about 0.92%, within the next five years. When can we expect a perceptible change?*

When it becomes 1.25.

*Is the government considering raising (doubling) the remuneration of JRF/SRF fellows and research associates?*

At present, there is no such plan on the board. There are also very special scholarships available (S. P. Mukherjee scholarships, 25 in all), five in each

discipline. These in itself are a good number. We are also having a CSIR students' scheme. We can only do as much as funds will permit. We wish to do it but....

### On some broader issues

*Can you elaborate on the necessity for having both a SAC-C and a Cabinet Committee on S&T? To the S&T on-looker, the SAC-C appears to be mostly non-functional. Your comments?*

SAC-C is making reports, many of its contents do not come in the limelight. They are working. They hold meetings and they make reports.

*There is a feeling that agencies are not treated at par. In fact, there is an unwritten 'social order' that is said to prevail. In this context, some of the agencies such as IMD (doing important monsoon research, vital to India), ICMR, ICAR, Survey of India, Zoological and Botanical Surveys of India need far greater support than they receive at present. What is your feeling?*

All scientific activities need support.

### On international cooperation

*Today China is an academically advanced society. There is a China-US Academic Programme. Are you also thinking on the same lines?*

I do not copy programmes. We also have established an Indo-US Joint S&T Forum.

*Are there any new plans afoot for regional cooperation in S&T especially with South-East Asian countries?*

We have many programmes, we are helping them. Their students are coming here. Also some of our institutions are going there, for example, Manipal is going to Malaysia, Indonesia, Bhutan and Nepal. Dabur has gone to Nepal. We have good scientific exchange with Bangladesh. And also with Myanmar. Whatever we have, we are willing to share with our neighbours.

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## RESEARCH NEWS

# A molecular abacus for electrons

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Counting electrons has been a favourite pastime for chemists. And for good reason. It was Mendeleev's intuitive counting, even before electrons were discovered, that gave birth to the periodic table of the elements. On the basis of magic numbers of electrons around an atom (2, 8 or 18), one could systematize a vast body of chemistry. The electronic properties of most compounds, complex as they may be, could be rationalized by counting the number of electrons.

Extra stability associated with planar conjugated structures containing a ring of atoms was pointed out by Hückel. If

$4n + 2\pi$  electrons were present, the ring had unusual stability and it was considered aromatic. Much later, Woodward and Hoffmann showed the importance  $4n + 2\pi$  electrons in reactions. The magic numbers associated with cage structures such as boranes were more difficult to unravel. Lipscomb was the pioneer in organizing the growing body of information in the sixties and seventies. The most succinct exposition of the rules governing three-dimensional structures came from Wade<sup>1</sup>. Wade's rules helped in understanding the electronic requirements of boranes, carboranes and other heteroboranes. In

conjunction with the isolobal analogy of Hoffmann, the stability of very complex polyhedral structures could be understood and predicted.

Extension of Wades'  $n + 1$  skeletal electron pair rule, where  $n$  is the number of vertices in a closed polyhedral structure, to a collection of polyhedra condensed to each other was not simple. The plethora of crystallographically characterized macro-polynuclear clusters involving metalloboranes, metallocenes and other heteroboranes kept many computational chemists busy, but no unifying principle seemed to emerge. The variety of ways cages are put