Whither traditional science and technology? [1]

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Tradition has always been important in India. We have *gharanas* in music or *shailis* in art. Sometimes we break tradition, as in *nai kavita* in Hindi literature. What sort of traditions do we have in science and technology? Do we even have such traditions? Many would dispute the point. Others would question the relevance of studying traditional science and technology. Science, they would argue, is universal, it includes every sort of science. By definition, it includes traditional knowledge as well as modern, so there is no point in differentiating between them.

However, traditional science and technology has been very much in the air in 1993. In fact, late this year, the Congress on Traditional Sciences and Technologies of India is being organized by the Centre for Technology and Rural Activities (CTARA) in the Indian Institute of Technology, Bombay, and the Patriotic People-oriented Science and Technology (PPST) Foundation, Madras.

The current emphasis on traditional science and technology has come in for close questioning. This is because, while seeming to posit itself against the present science-based model of development, it allows glorification of the past, the Vedas *et cetera*, and that fits in very well with the usual Hindutva hype.

An article in *The Hindu* (23 October 1993) describes the goals of the Congress. The authors take pains to point out that the Congress does not intend to take part in this sort of glorification of the past. That is reassuring, and I hope the organizers take care to delink the Congress from political associations like that of Hindutva.

Blind opposition to modern science and technology is also ridiculous. We owe many of our daily comforts and conveniences to today's science and engineering, and one doesn't wish to abandon them in the quest for tradition. The authors of the *Hindu* article also make clear that their approach is not opposed to modern science, but complementary to it. This sounds fine, except that it is best to spell out what aspects of modern science the Congress agrees with, what aspects it opposes, and what aspects of tradition it rejects.

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One of the truly astonishing events of 1993 (in science) was the Raj Kristo Dutt memorial lecture delivered at the Indian Science Congress by Shri M.C. Bhandari, Chairman, Occult Foundation. That a person espousing astrology and occult practices was awarded this honour by the Indian National Science Academy, which organized the Congress, raised a storm of protest in Indian science.

The contents of the talk (*Indian Skeptic*, September 1993) amply bear out the scientists' indignation. Here is Shri Bhandari's explanation of the *scientific* rationale of astrology.

"As soon as a child is born and his umbilical cord is cut, it is disconnected frrom its mother and it takes first breath. That is its exact time of birth from which its independent life starts. With its first breath enters into its body the planetary atmosphere existing on Earth at that time. That is the stuff of which it is made of. This stuff determines its personality, psychological make up and basic life pattern. How to assess the quality, quantum and character of this stuff? This is done by drawing out the map of sky at that time showing therein the exact position of planets in relation to the child's place on the date and time he took birth."

It is important that the Congress on Traditional Science and Technology convey to the public the view that it does *not* accept such nonsense as "traditional science." It is inevitable that the rise of Hindutva has led to increasing interest in vaguely Sanskritic subjects, and astrology is a prime example of this.

One aspect of the Congress that should be made clearer is its commitment to *all* the traditions of science and technology. Reading some of the articles in *The Hindu* on the Congress (during November 1993) shows a complete obsession with Hindu traditions, even Sanskritic ones. The tradition of science and technology from Islamic culture should also be welcomed into the Congress. In *India's Heritage of Science and Technology*, the Delhi Science Forum points out the contribution of people such as Fathaullah Shirazi in Akbar's court, who is credited with the invention of the idea of the machine gun, and Thakkar Pheru, a Jain minister of Allauddin Khilji, who was a mathematician and metallurgist.

The main emphasis of the Congress, we are told, is "putting tradition to work." The debate that is raised in this article relates to how much of this is possible at all. We will look at certain limitations of traditional science and technology, at least as it seems to be studied today.

In his article (*Frontline*, 9 February 1993), T. Jayaraman has shown how shallow the notion of "Vedic" mathematics is. Wiley Eastern has recently published a book on "Indian" mathematics (*Indian mathematics: an Introduction*, by Ashok Jhunjhunwala, Wiley Eastern, 1993). The author states in his preface that the book was prepared for the Congress on Traditional Sciences and Technologies.

Unfortunately, the author has chosen to present some of the dullest part of mathematics: arithmetic. For instance, in the last example contained in the book (after having gone through eight chapters), we have to find whether 352943 is divisible by 13. For this, the book proposes to use a "negative Ekadhika," do some manipulation, and come to something called a "Vetsana."

Now long division is sufficiently simple for a reader to prefer the technique he knows to what the author introduces. The whole book abounds with such questions: division, finding remainders, finding square roots.

It would be far more interesting for a reader to see the "Indian" proof of Pythagoras's Theorem, or an infinite series for π. This would still be accessible to school students. It is regrettable that the author, given his own familiarity with mathematics (he is a professor in the Electrical Engineering Department at an IIT) has chosen to ignore this richer aspect of Indian mathematics. What we get is a sort of rehashed version of "Vedic" arithmetic.

The style of the book could also do with a lot of improvement. It displays the same lack of imagination that characterises most school textbooks in mathematics: it is full of worked out examples and exercises. Certainly a more modern treatment could have been aimed for.

But the basic problem lies in restricting mathematics – or any scientific discipline – to one region or country. It is not just a case of "Vedic" or "Indian" mathematics, one could argue that the same is true of a notion of "Islamic" mathematics or "Greek" mathematics.

Where would Western mathematics have been without the Indian zero? Where would Srinivasa Ramanujan have been without the British textbook he studied from and the British mathematicians he collaborated with?

Those who argue that Western mathematicians (or historians of mathematics) are biased in favour of Greek origins miss out on this point. In fact, Western historians now recognize this lack of objectivity and try to include inputs from as many cultures as possible. To quote an example that comes to mind, a Conference on Algorithms in Modern Mathematics and Computer

Science was held in Uzbekistan in 1979. It included a detailed study of the work of Al-Khwarizmi, the Arabic astronomer from whose name we derive the word *algorithm*.

It is a pity that Indian mathematicians and historians, with their closer ties to Arabia, have not looked at Al-Khwarizmi's work in more detail. Let us take a quick look at his book, *Kitab al-jabr wa al-muqabala.*

How do you solve an equation like $x^2 = 40x - 4x^2$? Al-Khwarizmi suggests using *jabr* to do this. This has been translated by Westerners as "the algebraic operation of adding positive terms to both sides of an equation."

Instead, let us ask a Hindi-speaking child how to solve the equation. Chances are the child will say, "*zabardasti se* add $4x^2$." The word *zabardasti* comes from the same Arabic root as *jabr*, meaning force. Forcibly add $4x^2$ is what the child is saying. Surely this is what Al-Khwarizmi must have meant!

Or take an equation like $50 + x^2 = 29 + 10x$. Al-Khwarizmi calls this a *muqabala*. The Westerners translate this as "subtracting positive terms from both sides of an equation." But any child who is a keen watcher of Doordarshan knows what a *muqabala* is! Al-Khwarizmi is suggesting a contest between the two sides of the equation, which is "resolved" by cancellation.

No wonder Al-Khwarizmi's book has been so popular through the centuries. It is a lot more fun to see solving equations as a battleground rather than as a dull calculation. The study of things like *al-jabr* is now called *algebra*.

Observe what we did. We looked at some traditional science, we derived some benefit from being Indians, but we did not restrict ourselves to "Indian" science. We peeked into some "Arabic" mathematics and we gained some insight that an Englishman or American would be hard-pressed to get.

Science is of nature *international*. Scientists learn from other scientists irrespective of where they are. This was true long before international travel and electronic mail. The Greek, or Unani, system of medicine learnt from Ayurveda, despite having a different world view. Ayurveda learnt from the Unani system. Europeans learnt to use gunpowder, an invention of the Chinese. The Chinese learnt to use railway trains, an invention of the Europeans.

The trap that the advocates of traditional science and technology are falling into is treating science as wholly Indian or even wholly Hindu. They take pride in our invention of decimal numerals. But we should take as much pride in Al-Khwarizmi's treatise on them, which spread them all over the world. In Spain, decimal numerals are still called *guarismo* after Al-

Khwarizmi.

A second limitation of traditional science and technology is that there is so little of it! Indians developed some astronomy, bordering on astrology. They developed some mathematics. They were not bad at logic. They studied medicine and metallurgy. That's about it. No physics. No engineering. The myth about the Pushpak *vimana* in the Ramayana doesn't tell you how to construct an aeroplane. For that you have to go to the Wright brothers.

Again it is not that we wish to denigrate Indian science and technology. The same is true of Greek science or Chinese science. There was an explosion of knowledge after the Renaissance, and tradition usually doesn't include this knowledge. The whole question of "putting tradition to work" then doesn't amount to much, since there isn't enough to put to work.

In such a situation, traditional knowledge just becomes a means of establishing the primacy of texts. The "true" scientist is one who knows his texts. If you don't know the *Aryabhatiya*, or if you are so unfortunate as not to know Sanskrit, then you can be excluded from being an astronomer. Texts provide a theology which can be *imposed*.

This also brings to mind the fact that a lot of scientific data and investigation in ancient times was carried out for religious or semi-religious purposes. For example, we have an elaborate *panchanga* for maintaining a calendar, complete with extra months and all. What use can we put this tradition to? It is just unnecessary in our times.

In a dual manner, several of the problems facing us today were simply not there (or maybe not seen as such) earlier. Traditional S & T is utterly useless at solving them.

The Hindu has carried a series of articles on the careful management of water in tanks in Tamil Nadu in pre-British days. This seems to have served a village-based population. But today, a very large population is agglomerated into cities like Madras, leading to a severe water shortage. What is the solution for this?

Most people would agree that the major problems of the country today are a large population, poor sanitation, illiteracy, absence of medical facilities, lack of housing. What does traditional science and technology have to say about these? Precious little. No wonder, because the writers of the ancient texts were not addressing these problems. What, for example, is the traditional stand on family planning? Is it for abortion or against it?

It is sometimes argued that these sorts of questions are meaningless. The

authors of articles like the above are carrying out a historical study. One doesn't expect them to also pose solutions to contemporary problems.

Firstly, the authors are *not* historians. Secondly, historians of science are interested in studying the good *and* the bad things from the past. They wish to learn cross-cultural influences. Their study is informed by present day concerns. A historian of science, worried by the communal situation today, would study how Buddhist and Hindu scientists handled the expression of religion in their times.

Writers on traditional science and technology rarely do such a careful critical study of the past. They are usually interested in the rosy features which interest them. That is why their work is so eagerly taken over by the Hindutva movement.

Admittedly, Western science and technology has many problems. Our present model of development, based on science and technology, has come under severe attack on the environmental front. Strong, mass-based, anti-establishment campaigns led by figures such as Sundarlal Bahuguna and Medha Patkar have shown us the pitfalls of this model.

The organizers of the Congress on Traditional Sciences and Technologies seem to expect that bringing artisans and scientists together will suggest indigenous ways of solving such problems, rooted in our own ethos. It is welcome to see interaction between two groups of people, but is the communication of ideas equally strong both ways?

Traditionally, the Indian artisan has assimilated the knowledge accessible to him or her from everywhere. Our clothes comes down to us from so many diverse traditions and cultures. It would be an interesting question to find out where a popular dress such as the *salwar-kameez* came from. How did the embroidery of *zari* on Banarasi sarees originate? How did our crops and food habits develop? These are aspects of our life where different traditions have been totally assimilated.

The Indian scientist, on the other hand, has always been inward looking, guarding his knowledge zealously, and has never learnt from other cultures. Arabs, Greeks, Chinese, Europeans – all have translated Indian texts into their languages and learnt from them. But no foreign text was ever translated into Sanskrit.

This appears to be true of today as well. One finds attempts to publish books on "Vedic" or "Indian" mathematics in English. On the contrary, there seems to be no interest in translating a science classic like *The Feynman*

Lectures into Indian languages.

This is the main malaise of traditional science and technology, that it remains confined to a small section of society. In a sense, it has not built up a *tradition* of science and technology among people. Modern science has not fared very much better, but at least we see people from all sections wanting to become doctors or engineers. In the case of traditional science, there is another major cause for worry: that the arrogance of doing "Indian" science or technology will again shut out "dissident" influences from other sources. Without freedom for dissidence there is not much scope for science.