WHAT IS SCIENCE FOR?

Dunu Roy

Science Today, October 1979

Eleven years ago there was an earthquake in Koyna. It smashed buildings, frightened a large number of people, and an ominous crack developed in the prestigious Koyna dam. It even managed to shake a few who were studying technology in Bombay. If in those days somebody had asked us, “What is Science?” we would probably have smiled tolerantly. An earthquake merely meant that men had not been adequately prepared for a natural disaster and the business of science was to make men wiser. For us, the course was clear - we had to build earthquake-proof structures. So a design was duly prepared and we confidently went to the site and built a well-reinforced shed. It was a well-publicised affair and, basking in our own glory, we forgot to examine the utility of our work. Having built something for use, we neglected to examine how useful it was.

That wisdom came to us later - much later. We all learn slowly from our mistakes. This is the story of how we learnt to question the nature of “Science”. It is not necessary that we learn from our own mistakes only. We may also learn from the blunders made by others. So, the “we” in this story has not remained the same. It has changed over the years. But the growth in the cumulative learning experience has remained.

We were so reassured by our performance at Koyna that the next year we went to a village near Pune to carry on the task of development, as we then understood it. If we could build an earthquake-proof structure, we reasoned, surely we could teach the ignorant villagers a thing or two about the remarkable progress science had made in agriculture. So we read up on fertilisers and pesticides and high-yielding varieties and, armed with the latest literature from Pusa and Tata-Fison, we proceeded to the village. We were assured that the farmers would welcome us with open arms. The first three days soon disillusioned us. The farmers knew more than we could possibly teach them. In addition they knew far more about the fickleness of the weather, the varying market prices, the bad supply lines, and the unreliable quality. This was our first defeat, and the pedestal on which we had placed science seemed to shake a bit.

Observer and observation

Why was it, we had to ask ourselves, that in spite of the availability of technology, people still could not make use of it? However, there was no time to ask questions just then. We had to do something to shore up our self confidence. It had been a long haul to the village and we did not want to go back with nothing to show for our stay. We still had four days left. So we looked around and saw all those fellows squatting on the roadside and the women carrying their brass lotas. What the village evidently required was a sanitary facility. Full of enthusiasm, we once again fetched the bricks, the asbestos sheets, and the ceramic core, and

within a short while had constructed a toilet anyone we knew would have been proud of. We left after the inevitable inauguration, promising to come back during our next vacation. And that would have been that. Except that four months later we decided to raise some money through public donations for our next social venture.

In order to persuade our friends to part with their money we had to display some proof of our previous achievements. So one of us was dispatched to the village to take photographs of our contribution to public health. When he came back he reported that he could not take any photographs as the latrine shed was being used to shelter goats. His report generated a furore. It was immediately obvious that the villagers were a stupid lot whom no power on earth (and presumably, in heaven, too) could help. But one of our quieter colleagues retained a memory of our dismal effort with information supplied on agricultural practices, and he posed a question: could we possibly trace the stupidity to its cause? It was a critical moment. As we progressively traced back the failure of the villagers to use the toilet, it became clearer that it was we who were the cause. We had built a facility for those who did not need it and had ignored the requirement of a shelter for the goats. Science, therefore, is not merely based on observation; it must take into account the observer also.

From agriculture we turned to industry. Maybe, we thought, we did not know much of rural India, but we had the finest technical education the country could afford. Perhaps that could be used in industrial development. We had heard from our friends and teachers that small industry could not prosper because it faced innumerable technical problems, which it could neither solve by itself nor find adequate expertise to advise it on the solutions. We set up an “experts’ panel” to fill the gap. Acquaintances in industry and business, at the universities and research laboratories, were roped in to give freely of their time and knowledge. As part of our plan we let it be known to aspiring industrialists, and to development workers, that we were around in case they ever needed us to solve technical problems.

One of the first problems we received concerned an engineering graduate who needed finance for setting up a plastic extrusion moulding unit. Could we help? Our experts turned up their noses at that one. Finance, they said, is not a technical problem. Another of the problems posed to us was from a development agency in the tribal areas of eastern UP. They had a simple problem. At great cost and effort they had sunk a tubewell six inches (15.2 cm) in diameter and 250 feet (76 m) down and not struck water. They had heard it was possible to blast out a large cavern at the end of the tube-well which would collect water from the substrata and preserve it from evaporation for subsequent pumping out. They required 5,000 gallons (22,500 litres) of water for agricultural use. Could someone advise them? Our experts responded with enthusiasm.

One expert from industry said that the agency should drill further down to about 500 feet (152 m) for water. His company had just the rig to do the job. It cost only Rs. 2 lakhs. Would the agency be interested? A second admitted that he did not know any traditional explosives that would do the job, but he had some papers from the US on the use of atomic devices for blasting out underground cavities. He was enclosing the relevant references. 0f course, there was the little matter of radiation, but his research laboratory had done no work in these areas. Perhaps we could find someone else to advise us on this aspect? The third expert had the simplest solution of all. Look, he said, they've got a hole in the ground six feet (1.82 m) in diameter and 250 feet (76 m) deep, right? Now they need 50,000 gallons (22,500 litres). If you just do a simple mathematical calculation, you will find that the volume is much more than 50,000 gallons (22,500 litres). So what is the agency complaining about, anyway? This was about the point at which we decided that maybe the experts' panel wasn't such a good idea after all.

The experts asked for specific definitions of problems so that the problems could come within their area of expertise. But the people who were confronted with these problems were not equipped to define the problem. This business of science was getting a little complicated. It seemed that not only did the observation have to be considered along with the observer, but it was also necessary to consider the relationship between the two.

Clearly defined

For our next venture we decided that we had better select a problem that was clearly defined by those who wanted its solution, and that lay within our own competence to solve. An excellent opportunity for this seemed to arise when the 1972-73 drought hit Maharashtra. The rains failed, the streams dried up, the parched land offered no sustenance, the poor starved, even the rich did not know which way to turn. Aid poured in from all kinds of places. At the same time, somewhere in the committee rooms of Sachivalaya a decision was taken that this appalling waste should not recur. The administration was going to begin relief programmes but it would also concentrate on building for the future. If percolation tanks could be built wherever the terrain was suitable, then whatever rain fell could be stored, wells would not dry up, drought would be banished from western Maharashtra, and the poor would no longer starve.

We seemed to be ideally situated to survey, design, and build percolation tanks. So we offered our services. For two hot and dry months we scoured the countryside looking for places to build tanks, taking measurements through dumpy levels, rigorously following PWD procedures for the design of percolation tanks. It seemed that science was finally getting us somewhere. And so it was, until one day one of us wondered aloud: could we estimate the value of our work in terms of how much the people would benefit? That seemed a simple enough task and we began casual observations about what land would be fed with water, what kind of crops would be grown, and what would be the total benefit. It took us some time to realise that our observations were fitting into a pattern. It seemed

that an unusually large percentage of the land that would come under water belonged to the farmers with less than three acres of land, and those tanks would invariably feed the wells and benefit the lands of the affluent farmers, one of whom was the sarpanch and the others included village leaders and officials.

This was rather curious. Why was it that science was serving only the few? Was there something more to it than observation, observer, and their inter-relationship? The question seemed so important that we looked at it a number of times in a number of different ways. Let's see: we have the observation that when the rains fail there is no water, even to drink. This observation is made by us who are the observers. And the relationship between us and the problem of drinking water is that we are concerned about it to the extent of attempting to locate and supply water to those who need it. On the other hand, if the other observation, that this water seems to be generally going to those who are more affluent, is taken into consideration, then we (as observers) are not only concerned about the supply of water but are also concerned about those who need it. Which means that we have qualitatively changed. We are attempting to look at the problems of the poor not only from the point of view of availability of water but also in terms of their relationship with the rich - even though we ourselves are by no means poor. Does this mean that there are different categories amongst those who observe, as also what they observe? If the observer were not us but someone else, would his observation be different? Particularly if he were directly affected by the problem? These are the questions which led us into another area of exploration.

Conflicting categories

We had heard of a giant paper factory in Madhya Pradesh that was polluting the river waters which it consumed for the manufacture of paper. We had read a number of reports telling us the physical and chemical compositions of the polluted water. We could also compare these with ISI standards and come to the conclusion that the effluents exceeded the limits set by the standards. Clearly, as scientists, our task was to examine the technical factors of pollution and specify how it could be controlled to bring it within the tolerances set by ISI standards. But other technologists had done detailed investigations and proposed solutions before us and yet the water remained polluted. Would we not be repeating their fruitless efforts? Suppose, therefore, that we were to change our position of observation. For instance, could we examine the problem of pollution from the point of view of those who were affected by pollution? Would it not introduce a new dimension, which might lead to a solution of the problem?

This, then, is what we decided to do. We spent seven weeks investigating how the polluted water affected the lives of people. Did your cattle die after drinking the water? Did it affect milk yields? Does the water harm your feet when you wade across the river? How does it affect the crops? Have the fish in the water changed in any fashion? Does this harm your livelihood? And, for comparison, we surveyed a number of unaffected villages also. The result: cattle mortality

downstream of the paper factory was 141 per cent higher than the death rates upstream of the point of pollution. There was also a fall of 29.3 per cent in milk yields and a rise in the incidence of skin disease on the legs. For 20 km downstream, fish had disappeared from the river. We put all these details together and took them to all the relevant authorities. Surely science would triumph.

We first took it to the administration. They questioned the veracity of the report. Villagers are inveterate liars, we were told. The survey was, we were astonished to learn, “unscientific”. We next went to the paper mill. “Oh, don’t worry. The problem is very minor. There are two national research laboratories looking into the problem and we shall soon have a complete solution. We have already taken preventive measures and installed purification lagoons so that the effluent does no damage to animals and people. It is just that the water is a bit coloured. That is why the people are making so many complaints. And after all that we have done for them!” Dissatisfied with the kind of answer we got, we went to the pollution control authorities. “Ah, it is so good to see young people like you with so much dedication. If only all the youth were like you. Now, that is the trouble with the country today. There is so much to do and the younger generation is so lazy, it is unbelievable. Now in our days.....” We finally decided to approach the villagers. “Yes, yes, we know all that. The report does not tell us anything new. After all, you collected the, information from us only. Now tell us what you are going to do about it. Our cattle are dying every day. If you don’t have any solutions or any strings to pull in high places, then don’t waste our time.”

And so we were forced to look at our own report again. It seemed that not only were there observations, not only were the observers related to those observations, as also categories amongst them; but there were differences amongst these categories which made them opposites. It was almost as if these categories were conflicting with each other. Now what was it in science that supported, possibly created, conflict? We had always thought that science was neutral - a kind of omnipotent force standing aloof from the petty quarrels of men! Was it that science was seen by different observers in different ways depending upon how it benefited them? Was it then possible for one kind of science to be used to create riches and, at the same time, create poverty? Was it an instrument for the rich to make the poor poor, and keep them poor? And what happened to all those beautiful laws that were taught to us in school and college? Was it also possible that there was another kind of science which would help the poor?

This is what we decided to explore next. We took an area for study and thoroughly researched all the economic, social, and cultural data. We looked for the conflict situations and attempted to see how those conflicts could be resolved with the aid of science. We tried to see how knowledge could be used by the poor to solve their own problems. We looked at the gullies and nalas and saw how water could be collected. Could it now be taken to the farms of the poor? We

examined the implements and asked whether they could be redesigned to make the task of the labourer easier. We studied the organisations of the poor and asked, is it possible for these to take on new directions for fighting against the conditions that made them poor? Our training in science seemed to offer a method for finding solutions to these problems: define the problem, trace the effect to its cause, and eliminate the cause.

We found out where the poor farmers had their farms, and how water could be lifted from the reservoirs created by building small earthen bunds and taken to their farms. We found that a bigger spade with a bigger blade moves more earth and gets the job done faster. We assessed that if the poor saw the merits of these solutions, then they would organise to take the water to their farms on a co-operative basis; they would buy a bigger spade, move more earth, earn more wages; use their own initiative to implement the solutions we would suggest to them. However, we were not so sure of science any more. So, hesitantly, we approached the poor.

Perhaps we were wrong in being hesitant. Perhaps we should have been bold and confident. And perhaps it was this very timidity that made the poor speak bluntly to us. Why should they lift water and irrigate their farms, they asked, when the little they would be able to produce would take all their time and what would they earn in the meantime? Why should they move more earth when wage rates would remain the same or rise only marginally for double the work? And why did we think our solutions would solve their problems? For the first time, it occurred to us that our method did not go far enough; that behind the problems we perceived, there lay other problems that other observers could perceive; that solutions like those offered by us, are irrelevant precisely because they have no foundation in reality, and no idea of the basic problems that do not appear on the surface. But if we were not able to find the correct solutions because of our ignorance, why was it that the poor did not find the solutions either? They have the information; what prevents them from analysing their problems and coming to an understanding of how they could be resolved?

Common cause

We tried to evaluate our own experience in this light. What did our efforts teach us about people, both in the cities as well as the villages, that would serve to explain this question? The village with the latrine; the agency with the hole in the ground; the farmer at the mercy of drought; the milk producer with a dead cow; the labourer with the small spade; and all the others we know of (but have not mentioned here): did they have anything in common? Could we examine each example and find a common cause? Would this serve to explain why they did not do anything about their problems? And this cause would have to be from their point of view, not ours - for we had already learnt that science does not consist of observation alone, but that different observers, depending upon their interest, observe the same phenomenon in different and conflicting ways. We did a lot of

arguing and a lot of thinking, examining different probable causes and seeing which could best explain our overall experience.

And, presently, a hypothesis emerged. It seemed to us that in all the cases we knew of, people did not solve their own problems because of two reasons: firstly, available information with them led them to correlate different events in their lives in a fashion that made the problem appear insoluble - by them; secondly, the final cause was always some divine power. We found that these were closely related. For instance, the, man who tied his goats in the latrine was unable to correlate the seat in the ground to what emerged from his backside, but he immediately correlated the roof above to the needs of his animals and, in the process, blessed the divinity who, for some unknown reason, had sent those earnest young men to build the roof. The agency, on the other hand, tried to correlate its belief in “expertise” with the impossibility of understanding what the experts were saying. And it shrugged its shoulders - if the experts did not know then God alone did - and just wrote off the expense in its books. Equally, the labourer could correlate the higher output to lower wages but took the wage itself as given and not subject to challenge.

But, in a sense, the problem had been solved by putting it beyond one’s capacity to do so. Which is why their own reasoning process was supplanted by the leadership given to them by their heroes - temporal as well as spiritual. What drove us deeper into attempting to understand this hypothesis was our awed realisation that it applied not only to “people” but equally to us. We too correlated the bigger spade with higher wages, without attempting to go further into the matter. And for us the divinity was science. And in trying to persuade people of the validity of our solution, we were trying to enter into their pantheon of heroes.

Why?

If the hypothesis was true, what was the next step? How could “people” correlate events and find answers, and how could the divine barrier be pushed further back? Since the hypothesis applied equally to us, we tried to examine what was our own experience. How had we begun to integrate more facts into our understanding and how had we gone beyond the aura of science? We found that we had done this by setting an objective for every activity we undertook, and then examining our performance against that objective, comparing what we thought should have happened against what actually did happen; locating our failures and successes, and then trying to identify the factors responsible for the failure, or the success. And we were constantly asking the question, “why?” Is this the method of examining experience that had led us to challenge the kind of science that had been taught to us in school and college? And if this method is so powerful then, maybe, it is the real crux of science, the essence of understanding. We set out to test the hypothesis.

We are still testing it. Will people accept the need to understand their own experience? Will they ask questions of their own objectives and performance?

Perhaps the germ of the answer lies in the question itself, because if they do not, we will have to ask ourselves the question, “why?”

Eleven years is a long time to arrive at such seemingly simplistic conclusions and still not be sure of them. If ten years ago we had asked similar questions of ourselves, in our minds alone, we would probably have arrived at the same conclusions within eleven days. Which is why we are writing this: so that others more intelligent than us do not have to take the tortuous road of questioning the nature of science that is taught to them, and arriving at an understanding of science as a method of understanding.

How do we sum up? Science consists of asking the question, “Why?” until the answer satisfies you. If you agree with us you will say, “Why?” If you do not understand what we are saying, you will ask us, “Why?” and if you disagree with us, we will ask you, “Why?”