# SCIENCE AND SOCIETY*

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## INTRODUCTION

Modern Society is the greatest patron and the greatest benefactor of science. The majority of all the world's scientists and technologists from the beginning of recorded history are alive today, in no small measure due to the steady and generous support given to these endeavors. On the other hand, the functioning of a moden industrial society is unthinkable without the tremendous gains derived from and steadily being contributed by science and technology. While much remains to be done to eradicate poverty and misery and to establish social justice and equal protection of the law throughout the modern world, science and technology are helping in furthering these aims of mankind.

In such a partnership between scientists (and technologists) on the one hand and society on the other, there are inevitably questions of the role and scope of the mutual relationships and of the nature of the social contract. As the nations of the world become more aware of the importance of science in relation to society, the question of the obligations and duties of scientists and social control of scientific programmes comes increasingly to the fore. Many people of wisdom have devoted much thought to these questions.

The following paragraphs present one person's understanding and findings; he has benefitted from conversations with many of his colleagues at the Center for Theoretical Studies, Indian Institute of Science, Bangalore and elsewhere.

Scientist as a Citizen

Having been a scientist and having moved among scientists, it is natural for me to see scientists as citizens, as human beings. While this seems quite obvious to me, I am often amazed by the caricatures drawn of the scientist as a humourless, insensitive person unmindful of his obligation to society and unwilling to participate in the social adventure. Often we come across people, sometimes well intentioned and good people, who exhort us to be patriotic and involved, be humanists in our outlook and interested in communication with the masses: as if, by being scientists we have ceased to be ordinary citizens!

Like any other person, who functions within society, the scientist, too, is bound by a social contract; and as such, a certain degree of professional competence and performance is expected of the scientist. Among themselves the scientists develop and foster a notion of professional ethics, a code of conduct. This self-referring, self-correcting framework is the framework necessary for an organized scientific endeavour. To the extent that scientists of any nation lack this framework, to that extent the scientific endeavour is enfeebled.

Among scientists one often includes students and teachers of science, researchers on the frontiers of knowledge, expositors and propogandists of science including science writers and persons who influence science policy. In all these categories are people who have chosen science and whom science has chosen. But there are also others who took on science as a "civil service", as a living. In the sequel I shall

ignore these people, more or less and include others whose outlook is scientific, but whose pursuits are not formally identified as scientific.

What is the nature of the interaction between scientists and society? What is the science-society nexus? A scientist grows up in society, is provided his general and specialized education and, later on, receives continuing support and recognition by society. Society provides the environment in which science can grow and come to fruition. He gets a chance to "hob-nob with fellow wizards". In return, scientists do skilled work for society. Many of them work very hard and do it with wisdom, concern and dedication.

But the scientist should be given "special handling", if he is to function best. A certain specialized environment has to be provided, special loving care, of the kind that one would give to a costly scientific instrument. Not because the scientist is an instrument, but because it is important that scientific work must proceed most efficiently. This is a two-way street: society provides a specialized environment for the scientist to work, but in return, scientists furnish work done with devotion going beyond the call of duty.

Scientist as a Participating Observer

In the context of the mutual relationship between scientist and society we are led to ask about the role of the scientist as a leader versus his role as a follower: his role as a builder versus his role as a critic. What is the society to which he responds?

He who investigates the motions of celestial bodies and of sub-atomic particles, of biosphere and of self-replicating biomolecules should not be expected to accept a picture of society and its workings that is given to him from outside. There was a time when the heavenly firmament was supposed to be set in a crystal framework or when the circumference of a circle was taken to be precisely thrice its diameter; there was a time when women "did not have souls" and one man was considered to be superior or inferior to another by virtue of birth alone. There was a time in which the earth was the immovable centre of a universe. We have abandoned these views as incorrect or irrelevant and found better perspectives, more satisfactory models today. The scientific theories of a hundred years ago appear amusing to us now in many cases. That applies to social theories as well.

In many cases the new viewpoints make it easier to comprehend and compute. Instead of an earth-centered solar system with its epicycles, we find it more satisfying to employ a sun-centered solar system in which planetary orbits are practically circular. This is not to say that one does not deal with the earth in everyday life as terra firma.

So, also, with the scientist in relation to society. Most of the time he goes along with the picture adopted by the contemporary culture.

But when a particularly important question of principle is involved, he is apt to employ the analytical perception he employs in his scientific endeavor. He may ask you: What is the society to which I respond? What is the structure of the society and what principles govern its dynamics? Is our view of society a satisfactory one, one that could enable us to function more efficiently?

It appears to me, by and large, scientists should continue to perceive the society as a dynamical system and try to discern the forces that move society, study the model so obtained and improve on it as he goes on. But in everyday life he accepts the societal obligations as he finds them; to this extent he must limit his natural critical faculty and his individual freedom.

These twin roles of being a member of society and at the same time acting as an observer of society require considerable flexibility and integrity from the scientist. The observing scientist perceives society as a dynamical system and the forces he sees may not be acknowledged by society at large. Nevertheless, as a scientist, as a person of integrity, has to move in a direction which is contrary to the expressed dictate of the society to a certain extent. Any deviation from the mores of society will automatically mean that society will tend to bring the scientist back to the views held currently by that society. We may compare this with the situation of a spring which has a standard equilibrium position; any departure from this is resisted by elastic forces, but a persistent force can create a new equilibrium position. The work done in this alteration is not lost but stored as "potential energy" in the spring,

ready to be converted into energy of motion under suitable circumstances. So, also, with the scientist. The altered position that he maintains, if and when he does it, is one maintained by a conviction and this position carries with it the potential for movement for the benefit of society. Like the extra effort needed in packing a suitcase for a long journey, a scientist should strain against the restrictions imposed by society, if in his heart he knows it to be the proper thing to do, but do it only to the extent that it can be done without causing rupture.

To illustrate this let us consider the contemporary ideas on democracy and equality before the law. It is the simplest hypothesis to make, that in the absence of specific contrary knowledge, all people are equal; and, therefore, everyone must have equal opportunities. Everyone should have the right to look for happiness and well-being, to make use of the riches and facilities of the nation. But does this say that everybody <u>is</u> equal or should be <u>made</u> equal? The physical scientist is apt to look for a physical model for comparison. Consider a fluid made up of a collection of interacting molecules. For simplicity one may consider a dilute gas made up of identical molecules which go about their own ways but often colliding with other molecules. The molecules are identical and, therefore, they all have the same access to the total energy of the gas, but do they all have the same energy? They do not, at any time, have the same energy. For a dilute gas we know that the energy is distributed in a non-uniform fashion given by the "Maxwell distribution" which corresponds to a bell-shaped distribution function. The probable value of the energy is close to the energy shared equally, but some molecules have

much larger energy and some have much smaller energy. This is the natural state of affairs. If we deliberately worked hard to have strictly equal energies for all the particles, in a short time by interaction and exchange of energy between them the molecules would reestablish their distribution. It is idle to lament over this inequity in the distribution of "wealth".

Does this mean that we must always and under all conditions look for such a distribution? The answer is clearly negative. If we want the fluid to flow along a tube, we must not be content to have all directions of velocities equally probable; we must arrange for a preference for velocities in a particular direction. We may make use of an aspirator or some other form of a pressure differential to induce them to behave thus.

The scientist should thus perceive the dynamic nature of society and discern the laws and constraints operating on the functioning of the individual. If he is convinced that the forces are not bringing about the desired results, he should search for and bring into action other forces that could bring about a more efficient society. But throughout it all he must remember that while he sees the society as a dynamical system, he is a member of it.

Freedom and Constraint: Scientist as Rishi

In treating society as a dynamical system, while remaining a member of it, the scientist is aware of both freedom and constraint. In observing the nation as a functioning unit, the international scene in terms of its dynamics rather than its mottoes, and even the society of scientists, the individual scientist is painfully aware of restrictions that hinder movement. But this is only one stage of seeing: when he observes movement, causes of motion, and the underlying structure of the dynamics, he sees things as they really are. He sees that it is movement under constraints which generates forms, new modes of motion. Structure and form are the children of freedom and restrictions. If you had a flute with no bamboo or no holes, it would cease to be a flute; if you had a veena whose strings were not held taut, it could make no music. It is only when you have both movement and constraints on that movement that a structure can evolve. If you had freedom with no restrictions at all, then movement would be completely arbitrary; if you had no freedom and all restriction, movement would be killed.

The perceptive scientist, then, sees the dual structure of freedom and constraint as natural order, as the generator of form and structure; and ultimately, as two aspects of the modality of functioning.

Not only in his functioning within society, but also in his own spiritual search does the scientist encounter this situation. In fact, the spiritual path may be identified as a search for synthesis between the perspective in which individual will is paramount and the perspective in which everything is predetermined. If everything is predetermined,

whether in personal life or in society, there are no concerns and no cause for anxiety. If, on the other hand, we are free to do whatever we wish to do, then, also, there is no cause for anxiety. But we find that neither is a correct appraisal: we are both free and constrained. Frustration comes when we anticipate freedom and find constraints; and confusion when we anticipate constraint, a set of rules or some wise leader telling us what to do, and find that we are on our own. Both situations are unsatisfying; both are partial views.

The scientist finds himself more often in the latter predicament of having too much freedom and too little guidance and less often straining against the bit. This has a curious side-effect. Often, we find groups of scientists furiously pursuing the task of defining social goals and norms well beyond their normal realm of interest and flogging themselves to carry out these self-imposed strictures. For example, we find university faculty members getting passionately involved in such matters as curriculum revisions, participation in national defense-related research, preservation of an obscure biological species at all costs, settling questions of international diplomacy, and so on. We now find renewed awareness of the village basis of our society and so a large number of scientists in our country are involved in village technology, gober gas, bullock cart and so on. All these are legitimate pursuits and as relevant as discipline for a monk. But when this concern becomes pathological, in that it becomes a constraint on all; and like all excesses when it leads to the stifling of genuine creative scientific effort through excessive zeal and preoccupation with an isolated item to the detriment of its basic functioning, it is bizarre. It is like flagellation by a monk in

pursuit of discipline. Freedom is not indulgence any more than the attempt to discover the fundamental laws governing matter may be viewed as indulgence; nor is it intolerable to have laws and constraints any more than to have the law of gravity or the laws of electromagnetism intolerable!

The resolution to this issue of freedom versus constraints is the dawning of insight. Insight transforms the structure in terms of freedom and constraint into a complete and integrated system in which anxiety is replaced by knowledge. Transcendence is, therefore, not a negation of freedom nor is it submission to the inevitable. It is a recognition and conviction that both these are complementary aspects of a unified structure. Instead of seeing double vision and seeing two views, we get binocular vision and "depth" to the field of view. We do not see the flute as freedom and as obstruction: it is the integrated structure that is the flute, and that is what generates melodious sounds. Right perception brings about efficiency and, through efficiency, it brings mastery.

We say that a person has attained mastery, when he is able to function within the context of the constraints with ease, as if he is completely free. A talented musician has superb control over her voice and the sequence of rāgās and yet appears to do so effortlessly. A dancer or a tennis player appears to function without appearing to make the effort. In all these cases one recognizes the forces and patterns of the system and by judicious use of effort bring about the natural result. In other words, nature is taken on as an ally, rather than as an adversary.

This, then, is the proper relationship between scientist and society. The scientist perceives the dynamics with its attendant freedom and constraints, laws and options. He then makes the minimum effort to bring about the desired changes, in a symbiotic partnership with society. A scientist is a man of vision, a rishi, who functions within and with society harmoniously and effortlessly.

Science Policy as a Social Contract

Why should science be supported by society? The immediate answer is that since science is the knowledge of the structure and dynamics of the world around us, pursuit of science is the pursuit of ways of understanding the world so that we may function more efficiently, more effortlessly and more happily. About this there could be little disagreement. The scientists get supported by society and society reaps the benefit of the knowledge and insights gained by science.

The points of contention come on the strategy of this venture. How much support? How does one decide whether science has justified the allocation of scarce resources? Who determines what is supported, how far and how long? In short, who sets and executes science policy?

To assist us in arriving at answers to these questions, let us note a number of principles. First, since society supports scientific work and often has to allocate scarce resources to this pursuit, society has a right to negotiate the terms of this social contract. It is also clear that very often the specific pursuits are far from the concerns of everyday life. Scientists cannot possibly explain the full significance of their work to the citizenry at large. Third, like in all such intricate management problems, the details of science policy and science management have to be entrusted to people with special aptitude for it. Finally, the fruits of science are not always as visible as that of technology or commerce, though they are no less definite.

Most nations have agreed that while armed forces are necessary

for the defense of the country and as an instrument of national policy, ultimate control of the armed forces should be in civilian hands. The same applies to science. While science involves specialized training and talent, the ultimate control of national scientific effort should be in "civilian" hands. On the other hand, it would indeed be a foolish people who would interfere with the army commanders in the details of their task. You may hire a carpenter or an airplane pilot for a task, but, while you retain the freedom to reward or criticize the result of his work, you would not consider taking over the chisel or the airplane controls unless you yourself were qualified for the job. So, too, with science: once the national objective is identified and approved, the scientists must be allowed to carry out their task unhindered.

But, for scientists, most often the interference comes from either within their own ranks or from the science managers. People in our research institutions are constantly exhorted to do "relevant" things: relevance has become an end in itself. And relevance is often determined by short-term objectives and details rather than in terms of principles. And the most dangerous of such arguments are those that combine relevance with expediency. Recently I flew from Hyderabad via Tirupati to Madras. Suppose after the schedules are set up someone tells the pilot: "Why should we stop in Tirupati? After all, most of us want to get to Madras and we have important things to do there. Let us forget the few people at Tirupati and go directly to Madras." This may be a good argument and something that the airline corporation should take into account. But having taken that into account, we should not have to justify stopping in Tirupati each time one flies on that route. Science policy also, in the same manner, involves several levels. At one level we must decide whether

a certain area is to be pursued. But at another level we concern ourselves with how best to pursue it.

Our universities suffer even more acutely from interference in scientific pursuits. The responsibility of the state governments and local society, of the national government or political leaders certainly involves concern for the well-being of the scientists and the share of resources to be allocated for science in the universities; but equally definitely it does not warrant interference in the details of this pursuit. In Malayalam there is a saying to the effect that if you want a cannon to shoot properly, you should not get inside it, but stay outside and light the fuse!

We often see, as another facet of this state of affairs, the confusion of science with technology. Technology is the application of scientific principles in relation to technical and industrial problems. The fruits of technology are many and are essential to the functioning of society. And the frontiers of technology are much more visible and vivid in contrast to the advancing frontier of science. Most of the time out of confusion, though perhaps sometimes as deliberate misrepresentation, one tends to cite technological artifacts as the achievements of science. We talked earlier of potential energy versus kinetic energy. The second one, the energy of motion, is easily seen and appreciated. But the first one, the energy of configuration is just as real and can be converted into kinetic energy. The relationship between science and technology is

and are real assets; they may be converted into movement of industry and agriculture and then they are seen as technological progress. But to view only the latter and not the former is to disregard the roots and consider only the shoots. Technology without a science base is like a collection of cut flowers. Sometimes one has to use cut flowers, but one hopes that a garden of flowers can be made to grow up as soon as possible rather than keep on buying cut flowers.

Yet another misidentification is science administration with science. Science administration is very important and cannot be entrusted to just anyone. Just as an engine driver is to be a skilled person, a science administrator has to be skilled. But it would be silly to consider the engine driver to be the purpose for the train and the passengers to be his followers. So, too, with science. Very often science administrators are scientists of more or less demonstrated ability, but functioning as an administrator should not be interpreted as making him or her a greater scientist. Nor is it true that a better scientist is a better science administrator: sometimes quite the contrary is the case. In the context of the rapidly expanding support for science, the science managers have done very important and commendable work. As the body of scientists acquires maturity and self-reliance, wisdom and insight, these understandable confusions will gradually dissipate.

Before leaving this topic we must also allude to another confusion. Since science goes forth discarding, testing, strengthening, and searching much of it is new. Traditional knowledge in some of these areas is tantamount to discredited knowledge. This does not, however, mean that science

is opposed to traditional knowledge. Quite the contrary, in fact: when one understands the basic principles of some branch or other of science, they resonate in an uncanny manner with traditional knowledge and sacred texts. If the student of molecular biology finds the opening verse of the Gospel of St. John, or the student of quantum field theory finds certain verses in the Bhagavat Gita relevant, one should not be anxious to disregard these correspondences. The Sufi masters, or the Rishis of Rig Veda sound extremely modern with regard to the study of altered states of consciousness. As long as one does not get into the position of maintaining that all scientific discoveries are contained in traditional knowledge, there need be no opposition between traditional knowledge and scientific knowledge. One does not have to give up one's cultural moorings to become scientific!

Science as Society's Path to Fulfilment

The resolution of the predicament of the scientist as observer-critic and member of society in itself, also gives the best answer to "Why science?" When faced with laws and constraints and freedom to act as well, the wise man attempts to comprehend the laws fully so that he may use his limited freedom efficiently. He becomes an adept. This passage from insight to adepthood frees much of one's initiative to truly creative pursuits.

Man is born to be happy. Disharmony comes from disarray, from misunderstanding. As one understands the nature of one's existence and functions efficiently within it, one's creative energies are freed. The routine things that are to be done no longer absorb one's attention. When you first learn a language, you devote much time to syntax and grammar, idiom and vocabulary. But as your command increases and you become well-versed in the language, these are taken care of automatically and the real task of language, the communication of ideas, can get all the attention. Even the limitations of language no longer are bars. The great teachers among us always find simple language to communicate profound ideas.

So, too, in the biological world we find that as an organism evolves, it reaches the stage when homeostasis is an involuntary function. Instead of attending to the details of immediate existence, the system is enabled to expend its energies in other directions. The spiritual path is the second level of homeostasis in which one achieves the status of a "sthita prajaṅa", one who sees the world as it is without trepidation and without frustration. Constraint and freedom are now no longer seen

separately, nor are value judgments placed on natural laws. Functioning becomes efficient and spontaneity becomes the rule.

Society, too, can be considered as an organism. Subject to stimuli and yielding responses, adjusting its function to the situation in which it finds itself, it too is functioning as an organism. Civilization is the first stage of homeostasis, like the passage from simpler organisms to a warmblooded animal. But there is a next stage where spontaneity is the dominant modality. That comes when freedom and constraint are integrated, when tradition and discoveries are seen as not in opposition. In this society scientists would function efficiently and almost everyone would function in the scientific mode.

It seems to me this is human destiny and, to the extent that it is being accelerated, science is fulfilling itself.