MASTER-2

Bangalore, May 1976.

Private Science and Public Policy

by

V.Siddhartha *

Panel Corrections are at last to E & P. weekly.

As a product of a socially organised activity, scientific knowledge is very different from soap; and those who plan for science will neglect that difference at their peril. - J.R.Ravetz in Scientific Knowledge and its Social Problems. 1/

And, Ravetz might have added, at the peril of science; for what fate befalls planners of science is rather less important than the future of science itself!

The universe of relationships that govern scientists, science and society consists, in essence, of three worlds. World 1 is the private world of the individual scientist and his science; World 2 is the public world of technology, economics, ideology, power structures and patronage; and World 3 is the in-between world of the community of scientists, its peer groups, its internal 'political' leadership and of the structure of science as it is shaped by this community.

About World 1, not very much is known. Apart from a few glimpses into this world that have been provided by biographers of scientists, 2/ a few Nobel orations, 3/ and the odd autobiographical account 4/, private science has remained largely private. The early literature on the philosophy of science tried to discover universal attributes in, or ascribe them to, the relationship between a scientist and his science. Much popular literature still refers to 'the scientific method'. But, surely, we are all Kuhnians now. 5/ Scientists do not do Science. Science is what scientists do. By implication, World 1 must, in order to be described, make reference to World 3.

---

* Systems Planning & Analysis Group, Indian Space Research Organisation (ISRO), Bangalore 560 009. The views expressed here are those of the author. They are not to be construed as being necessarily those of ISRO or of any other organisation.

... 2

In contrast with the scanty literature on World 1, World 2 has been almost the exclusive concern of the extensive literature on Science Policy and on science, technology and development. Science Policy, both as an academic discipline and as one of the shaping instruments of public policy, matured very considerably during the sixties and there is now a clutch of concepts and theory on science, technology and development which may be recognised as the common currency of this body of knowledge. Yet, whereas economics and the response of societies to innovation have figured fairly prominently in the literature, the behaviour of leadership groups within the scientific community and their links with the political process have not, generally speaking, been seen to be of very great importance in the formulation of policies linking technology and development. 6/ Thus, studies of World 2 in developing countries make little reference to World 3.

Thomas Kuhn should perhaps be credited with being the first to open up World 3. Parts of it have been described by Medawar 7/ and Ziman. 8/ by Ravetz has studied it in extenso. An important part of World 3 - the scientific community - is a significant elite grouping in most societies particularly in developing countries. It is somewhat surprising therefore that it has not been the subject of the attention it deserves in the literature on science and development. 9/

This essay is a preliminary exploration of the role in our society of World 3 in shaping the other two.

Scientists in a stratified society

If the mere act of living at a relatively high level of consumptive affluence in any strata can be shown to be an immoral burden on the rest below, how is one to justify any action at all? If the pace of erosion of social inequality may not be fast enough to stem revolution, bloody or otherwise, what is one to do in the interim? When you are not only stratified but over-populated as well, the noble activity of alleviating human suffering can also be called into question and even the love and charity of Mother Theresa can be thought to be counter-productive. So what does one do?

... 3

Well, we all survive and some of us do very nicely, thank you. But for some reason scientists are not allowed the ordinary hypocrisies of life. Why did they perfect dwarf wheat and make the rich farmers richer? Why do they research into Atomic Energy when cow dung is the fuel of the masses? Why fund R & D on slurry-pipelines when the bullock-cart is the main vehicle of transport? And so on.

Posed in this fashion, these questions cannot be answered.* This is not to say they are bogus, but that they are the wrong questions. The resolution of the social problems of science, and those caused by the application of science and technology, is strongly dependent upon the social and political context in which these problems occur and upon the self-consciousness of the communities and elite groups that act as gate-keepers between the various relationships relevant to scientific activity in our highly stratified society.

awareness

The dilemma of the socially committed scientist

In such a society the locus of the impact of institutionalised scientific and technical activity in its most general sense (i.e. including activity involving para-technical personnel such as mechanics, artisans, nurses etc.) is wholly confined to the top ten per cent of the population, if that. Even those scientists who acknowledge with all genuineness that they are, in some sense, 'responsible' to society must ask themselves which part of society they must be socially responsible towards. If your salary and your laboratory have been made possible by taxes, then the first charge on your sense of responsibility is towards the tax-payer and his call. How is this call to be heard? As elaborated on later, the call is heard through those instruments of public policy as are actually pursued and implemented. And the responsibility, how is that to be judged? To rephrase Ravetz: we can say scientific activity

---

* There is a type of smart-Alec commentator who calls scientists to account in this fashion but whose purpose is merely to appear intellectually chic. He can and should be ignored. Too many of them have injected a paralysing guilt into the minds of our scientists and technologists, particularly the younger set. But morale cannot be raised by a mere rally to the flag. Only the most honest self-examination and continuing dialectic can, piece-meal, resolve the issues.

... 4

becomes irresponsible 'when the actual goals of the tasks accomplished are contrary to the professed social functions to a degree that a public trust is betrayed'. 10/

Public trust is reposited in roles. Thus the philosophy behind the formulation of a Science Policy by scientists qua scientists depends upon the role the scientific leadership is expected to play while preparing it. This expectation can and does differ a great deal as between the political leadership, the bureaucracy, the professional economic planners, the working-level scientists and the scientific leadership itself. Furthermore, in so far as the expectations are really perceptions by the formulators of what is expected of them, signals from the various communities have to be read and how they are read and responded to depends, plainly, upon the political ideology of the science planners as also upon their integrity.

The role played by the first National Committee on Science and Technology (NCST)* is an interesting case in point. In 1972 the NCST was asked to prepare a national Science and Technology Plan as an adjunct to the nation's Fifth Five Year Plan. At that time the Planning Commission was working on a document called 'An Approach to the Fifth Plan'. The NCST was asked to prepare, in parallel, an analogous document which would outline the strategy and policy-frame+ for the Science and Technology Plan. The NCST knew, of course, that nowhere in the world was there available even a rudimentary methodology that would explicitly link scientific and technical activity to economic goals at the level of aggregation that the Planning Commission was known to be playing with. Further, despite much talk and much patient education, the public administration network, dominated as it is by the not un-intelligent but hopelessly mal-educated IAS, had utterly failed to appreciate the various dimensions of the management of technology. The gap between intent and implementation was widening. So the NCST responded to signals from the scientific community

---

* Composed, as an act of deliberate policy on the part of the Government, of 'leading' scientists who were not heads of the scientific agencies.

+ This is an unhappy phrase but one which is in common use. It means, as I understand it, the range of matters in the realm of public policy that are germane to scientific and technological activity.

... 5

and from the political leadership which were both reflecting an 'unease about the rate and direction of our scientific and technological progress' by casting themselves in the role of managerial economists. As a result, one of the most succinct and comprehensive, even if somewhat disjointed, statements of the current wisdom on science, technology and development was published in our country by the NCST as 'An Approach to the Science and Technology Plan'. 11/

Technology and Development - the neo-keynesian paradigm

The socio-political goals of 'self-reliance' and 'meeting minimum needs' had been enunciated earlier by the Planning Commission. The first goal had, in fact, been urged upon the nation by scientists and technologists for many years before its formal adoption by Government. Given these goals, the relationship of technology to development was interpreted in the Approach through a demand-supply paradigm. Crudely put, there is an oversupply of indigenous technology (provided by an oversupply of indigenous technologists?) waiting to replace foreign sources of supply, often on a one-to-one basis. There are some problems of quality and cost but by suitably juggling the discount rate, the shadow price of foreign exchange and taking into account the very real and growing deficit in the technological balance of payments, it is not difficult to demonstrate that indigenous technology is to be preferred. Self-reliance means, in this paradigm, the achievement of a zero deficit in the balance of payments, particularly in the technological component of it.*

The Approach did recognise explicitly the existence, indeed the persistence, of "dualism". 12/ But here too there was an implicit postulate of over-capacity in the institutions geared to provide the relevant scientific and technological 'inputs'. Thus, "The pattern of demand for such knowledge as will affect the rural sector will depend very crucially on how well we orchestrate a whole gamut of policies concerned with that sector". 13/

---

* As distinct, that is, from balance of payments arising on account of trade in pure commodities. Specifically, the trade in (largely import of) armaments would be accountable against 'technological balance of payments'.

The major contribution of the Approach was a listing*, and a forceful argument which highlighted the predominant influence of various instruments of public policy on the 'demand' for indigenous technology. As a consequence, slowly, but recognizably, some of these instruments of public policy are being re-shaped to remove some of the barriers to the growth of this demand. 14/ Thus, management of the demand for technology was what the Approach was all about. The paradigm was neo-keynsian, the theme was self-reliance, the solutions proposed were managerial.

Informed criticism of this document has focussed around the ideological contradictions supposedly implicit in the ideas presented as these were sought to be applied to the Indian situation. In essence this criticism maintained that the existing 'demand' for technology was sharply skewed in favour of the metropolitan sector and all that the Approach sought to do was to attempt to arrange policies so that foreign supply was replaced by indigenous supply. Furthermore, that there was no shortage of 'demand' for the 'right' kind of technology of relevance to the non-metropolitan sector, in the rural areas in particular, and what was required was a deliberate effort on the part of the scientific community to provide such technologies as these were in scarce supply. 15/ One noted that there were no implications of this criticism for public policy beyond what had already been stated in the Approach; there was only an exhortation to the community of scientists to rise to the occasion and, for good measure, to ignore the NCST.

If the Approach emphasised 'demand-pull' innovation; its critics operated on a 'technology-push' theory. In fact this alternative theory of innovation (well-known in the literature) was projected as an alternative, radical, strategy of development. In this counter-paradigm, the essence of the problem of linking technology to development is choice of technology; where a desirable technology is not available, suitable investments in R & D will provide it. If the Approach was neo-keynsian, its critics were, in a sense, neo-classical.

---

* Originally due to Graham Jones in an unpublished report to the Science Policy Research Unit of the University of Sussex.

Was a public trust betrayed?

The answer depends, of course, on who 'the public' are and what the nature of the trust was. The criticism of the Approach only served to underline what the NCST knew but did not elaborate upon; namely, that the process of Garibi Hatao is primarily politico-economic. The political will is communicated through the reality of those instruments of public policy as are actually pursued and implemented; not through the rhetoric of the vote-seeker. 16/ Science by itself cannot hatao garibi; science can only help to make the process more cost-effective.* Put in another way, the influence of technology as a factor of production, and as a distributor of welfare, decreases very sharply as one goes down the social ladder. At the very bottom, on the landless labourer with no access to employment, the influence cannot be anything but nil. But 'the public' did not, surely, expect from the NCST a homily on the political economy of garibi hatao.+ If journalistic criticism is anything to go by (there was scarcely any other kind), 'the public' perhaps expected a series of technological fixes to deliver it from the capitalist crisis compounded by extreme dualism; and hence perhaps the almost universal approbation for plans proposing 'alternative technology'. If this was so, it was not public trust, it was public self-deception.

To propose an alternative strategy of development which implies, among other things, the availability of alternative, or 'appropriate', technologies and then to propose that these technologies be considered research-worthy is a perfectly legitimate activity for an individual scientist, or a group or an association, formal or informal, of like-thinking scientists. It would even be legitimate to elevate the non-availability of alternative technologies to the position of the reason for under-development so as to be used as a motivating force to declare certain problems as research-worthy. But it would be self-deceiving belief in one's own propaganda to consider this to be actually so. Certainly the

---

* The numeraire for the cost-effectiveness ~~calculation~~ assessment need not be money. It could be energy, leisure time, cooking-utensils-per-adult-female etc.

+ The predicate phrase is also the title of an article by ~~Prabhat Patnaik~~ Randive in the Economic & Political Weekly. ~~I am unable to retrieve the precise reference.~~ of 5 May, 1973

scientific leadership charged with the responsibility by Government to plan for Government cannot believe it. To do that would be a betrayal of the public trust.

The Science and Technology Plan

The process by which a set of problems comes to be considered as research-worthy is inextricably intertwined with the sociology of science and with the social psychology within the community of scientists of those who are ultimately expected to do the work. Once identified as being research-worthy, whether the problem is researched on or not is a matter of funding and management; whether it is researched well depends upon the competence of the research group and whether the solutions find practical application to the degree originally envisaged is dependent on such matters as those elaborated on in the Approach.

Simultaneously with setting the policy-frame, the NCST, through its numerous panels and steering groups, identified a long list of research-worthy areas. 17/ Required funding was decided largely by judgements about what the existing infrastructure could usefully absorb; choice of research-worthy areas, relative emphasis and who-does-what was decided by peer-group review of research proposals and by subtle and not-so-subtle power-play interspaced with gentle 'you-scratch-my-back, I'll-scratch-yours'!* As for judgements about competence, these were altogether dispensed with; the panels were too large and too un-anonymous for such judgements to be made. Everybody knew that after the working budgets were actually allocated (through the various Ministries), money would become tight and each area would be re-scrutinised by panels of scientists in meetings with different group-dynamics than those prevailing in the large, open meetings of the NCST panels. The real choosing would be done then. Nobody had any illusions about the extent to which worthwhile results could be achieved.

---

* Lest some readers think this a shocking revelation, this is, by and large, the process of resource allocation in Government-funded R & D in almost all countries. The process is controlled quite effectively both in India and elsewhere by internal social mechanisms within the scientific community that enforce a modicum of quality control and provide adequate protection against outright fraud or blatant waste. These mechanisms are central to the survival of science; they are the subject of attention later below.

The estimate of the proportion of areas researched on that might yield results varied between individuals and groups but did not exceed 50% in any case.*

The NCST exercise was almost wholly confined to general industrial technology covered broadly by the Council of Scientific and Industrial Research (CSIR) and the health sector, covered broadly by the Indian Council of Medical Research (ICMR) - a poor agency with no independent 'pull' of its own. The areas of Agriculture, Atomic Energy, Space, Electronics and Defence were not planned for in this fashion. The plans in each of these areas were taken to be those formulated by the respective agencies concerned. To elaborate on why this was so would require a separate essay.[18] But the basic reason was that the Departments of Atomic Energy, Space and Electronics have been charged quite explicitly by Government to plan for themselves through their respective Commissions and the role of the NCST vis a vis these was (and still is) unclear. Defence research could not, obviously, be discussed in large open forums.[19] Agriculture had well-defined goals from which the relevant research tasks could be derived fairly directly and the concerned agency - the Indian Council of Agricultural Research (ICAR) had been planning its research for some time through a process similar to that adopted by the NCST.

That these omissions are significant becomes patent when one notes that sixty per cent of the funds expended on R & D in the central sector in 1973-74 were accounted for by these heavy-weight agencies alone.[20] Thus the NCST was really planning primarily for CSIR and the public-sector enterprises. In the process it also identified neglected areas and urged their support - both institutional and financial.

Could it have been otherwise?

The "Allahabad-Calcutta research axis"[21] of the thirties and forties had gradually been superseded in the fifties and sixties by the somewhat broader "Bombay-Ahmedabad Axis" of the Bhabha-Sarabhai years. The

---

* The first chairman of the NCST, C.Subramaniam, was himself under no illusions on this score. At one of the public discussions of the Approach arranged by the NCST, he declared that even if no more than 20% of the research programmes fructified, the exercise would have been worth the trouble.

sixties also saw the growth of ICAR through the driving force of C.Subramaniam and the rapid growth of scientific institutions and advanced-technology industries around Bangalore. By the time the NCST began its exercise, a new post-independence generation of alumni of the IIT's had taken up positions in various middle-ranking driver's seats in the research agencies and in the public-sector enterprises. Personal loyalties were replaced by group loyalties which were looking for a focus. An astute historian could perhaps have predicted the emergence of an NCST from the Third Conference of Scientists and Educationists* as a natural outcome of younger aspirations. Although the Axes had thus become diffused, the mandate of the NCST was a result of pressure from below rather than the result of a need perceived at the top. It was therefore vulnerable to dilution by the Axes powers.

Given this contemporary history, and the lack of a developed methodology of planning for science in development, the NCST exercise was no mean achievement. The latter point is important; for, if the conceptual and procedural aspects of a planning methodology are sufficiently robust, one can overcome some of the debilities that history imposes. But no such methodology exists. Consequently, the NCST could hardly have done other than what it did.

It is becoming clear, I believe, that the search for a methodology of planning for science in development+ that is structurally invariant in time, even in the short-term, is bound to fail. This is not so much because attempts to develop them are being made by economists who do not know anything about science (i.e. the subject matter of it)@ but because the nature of scientific activity is so intimately bound-up with the collective ethos and social situation of those engaged in it. Science is not like soap.

---

* Organised by the erstwhile Committee on Science and Technology (CoST) in November 1970.

\+ As distinct from methodologies designed to promote the achievement of well-defined research tasks through programmed Research and Development using known science.

@ The irritating pomposity of some economists venturing into this area betrays an insecurity born of an inability to come to terms with the fact that scientists do not find it difficult to understand economics, but most economists find it very hard to understand science. They tend, therefore, to maintain that it is unnecessary to understand it. No other attitude can better guarantee failure to the attempt to understand the relationships between science, technology and development.

... 11

There is another important reason; it has to do with the poverty of economics. But to go into that would carry one too far afield. 22/ It will have to suffice to mention that because the nature of one of the most important instruments of change - technology - is a function of change itself, only an operationally dynamic view, abstracted into a working cybernetic model, can provide the managerial tools for the planning and steering of a developing economy. 23/ Economists will take many years to understand this and still longer to assimilate it into their working ideologies. Until then we will have to learn to live with them!

Mature advocacy with immature science - the new politics

If the search for a methodology of planning for science in development is otiose; and, following Kuhn, science is what scientists do rather than it being the other way around, are we to conclude that Science Policy equals the sum of public administration,* the containment of mob-psychology and the end result of power-play amongst the 'barons of science'+ ? Where, if anywhere, is there a role for the professional scientist? The answer to the first question cannot be yes, otherwise we surrender to chaos - or a close approximation thereto. The answer to the second is perhaps best obtained by looking upon development as a continuous process through which a people 'learn to cope with the privileges and burdens of choice'@.

As our population grows towards a billion; as land, water and energy become scarcer and as the pressure on the cities from outside and from within them rises inexorably, the scale of decisions will enlarge and the time available to make them will diminish. Each element of public policy will affect more and more people and as the acts of legislation and decision-making become steadily more burdensome, the temptation to sacrifice the adaptability of complex organisation for the apparent manageability of simpler systems will become steadily more difficult to resist. In consequence, the fidelity of communication and control will become coarser, so that oscillations between anarchy and repression will become more frequent and bigger in scale.

---

* Discussion with P.M.Bhargava: "The Approach could have been written by a committee of Secretaries to Government".

\+ Phrase attributed to P.N.Haksar.

@ Margaret Mead in a film on her visit in 1965/6 to the Manus of New Guinea whose people she had first studied in 1928.

... 12

Unless, that is, the burden of choice can be lightened and the privilege shared. The scope is vast for the professional scientist to do both of these things, but to partake of it will tax to the limit his integrity and his resources, both intellectual and physical. The burden of choice is reduced in proportion to the confidence that one can cause to be established in the anticipated consequences of alternative public policies. Yet, it is precisely in the matters of establishing confidence and anticipating consequences that a scientist faces the most acute ethical dilemmas and disheartening professional impotence. Anticipation is a difficult art. 24/ Methods of anticipation that are anything other than astrological run the gamut of maturity from physics to social biology.* The scientist is frustrated by the need to bound his concern within limits that are much closer than those he would permit himself were he limited by his imagination alone. For, in science as in history (to misquote Mead 25/) "the grand design without the detail shakes belief and trust to the core." Yet, the evidence shows that in matters concerning Man and his environment, small causes do not necessarily have small effects and limiting one's concern may only cause the anticipated outcome of a particular instrument of public policy to be wholly unrepresentative of the totality of the possible effects.

In the coming years major decisions will be made that will shape the relationship between our people and their environment; for example, on the growing of mono-cultures, on the control of pests and predators, on the management of forests, on the management of limited water supplies, on compulsory birth-control, on transport systems, on housing and urban growth, on nuclear power and on national security with or without nuclear and other more terrible weapons. The effects of these decisions will become visible within the lifetime of our younger scientists. A great many, perhaps the majority, of the questions raised will be incapable of being answered unambiguously (if they can be answered at all) because the appropriate sciences have not progressed sufficiently or quite simply because there is insufficient time to gather all the relevant data and to analyse it. For a scientist trying to answer the questions the temptation will be great to exchange local power for truth; to proclaim certainty when only possibilities can be indicated; to say "I know" when he doesn't.

---

* I am not suggesting that astrology is a valid method of anticipation. But one must sadly acknowledge that significant numbers of our people, including scientists, have confidence in astrological 'predictions'.

In such a situation, the role of the responsible scientist is clear; he must do his homework as thoroughly as he can, state his premises and the proficiency of the knowledge he deploys and then be unafraid to advocate a course of action, despite the uncertainties in his immature science. 26/ He will then be a political animal, very different to the usual kind and much more valuable.

Having thus become a participant in the new politics, the scientist must be cognisant of the political context; the real one as it exists on the ground, not the professed one as emerges in political speeches or through the distorting filters of the news-media. This political context is provided by the decisions actually taken and by the set of instruments of public policy that are implemented. Their effects on the large-scale can perhaps be gauged from published information. For their effects on the small-scale one would, I suppose, have to travel a great deal. In sum, the context will define the content. The background, to quote Kosambi, is all important. 27/

With such a role for the professional scientist connecting World 2 to World 3, Science Policy will emerge as a coherent package of explicitly made political choices between alternative courses of state action maturely advocated by scientists qua scientists constrained by, and in turn constraining, the scientific community. Two matters will remain: the extent of state support for basic research and an ideology for scientists that will merit, and might command, universal political respect.

Control of quality - the warrant for basic research

If mature advocacy is to carry conviction and if it is to be prevented from degenerating into corrupt self-interest, the proficiency of knowledge in handling ever more complex problems must be steadily enhanced. If the privilege of choice is to be shared, science must become more communist. It is not only in principle that science must be accessible to all those who submit to its rigours, it should be so in spreading practice. Neither of these requirements can be met unless the foundations of science are continuously strengthened, and the detail filled-in. Only the very highest quality of material can be permitted to be used for these tasks if the entire structure is not to collapse.

... 14

The control of quality is one of the most difficult internal social problems encountered in our scientific community. Patterns of etiquette derived from European practice, particularly the practice of recognising and acknowledging adjudicating peers, both tacitly and explicitly, form the basis of the quality-control procedures. These patterns are wholly foreign to our traditional culture. They exist in precarious symbiosis with other cultural practices in our scientific community that are antithetical to the scientific ethos. It is for this reason that the professional scientific journal - the main quality-control device in science - is practically non-existent in our country. 28/

Nature is the fairest and the most unyielding arbiter. The fundamental problems she presents are the primary touchstones that are used for the detection of shoddy science. The conduct of basic research is the only way in which the quality of science can be ensured through the submission of the claims of competing theories to the evidence that nature provides. Theories mature into paradigms, their forebears are forgotten, many of the original obscurities become irrelevant, and a 'standard version' of knowledge is admitted as part of the foundations of science. Until, that is, it is usurped through a scientific revolution and replaced by another one. This process is an integral part of the metabolism of science of which basic research is the life-blood and connecting link between World 1 and World 3. Without basic research the entire social enterprise of science will collapse, more rapidly in our society where most of the social practices of this enterprise are not indigenous to it.

How much basic research and in which fields will be the subjects of continuous debate and argument. There will never be any long-lasting formula for the proportion of the national science budget that should be devoted to it. 29/ We must remember though that "we take serious risks if we put scientific research and development in the bed of Procustes and chop off its head in the name of financial difficulties". 30/ Only scientists can decide this proportion. Society must allow them to retain their delegated power to do so. For their part, scientists must cultivate an ideology that will merit political respect.

... 15

Trusteeship - an ideology for scientists?

Scientific knowledge is now recognised as the fourth factor of production additional to Land, Labour and Capital. Much political doctrine has emerged from theses about the ownership relations amongst the traditional factors. But little has been said about the ownership of the fourth and the relationship between the owners of this factor (the class of people called scientists) and the owners of the others. Some thesis about this relationship must, surely, form the basis of an evolving ideological anchor for the souls of scientists. Without such an anchor science will either wither away or become the handmaiden of the most grotesque forms of exploitation of both Man and his natural environment. Either event will be a tragedy from which we are unlikely to ever recover.

Trusteeship is an old idea. Gandhi, for example, tried to propagate it as a practical organising principle of economic activity. 31/ Its applicability is greatly limited, however, by the fact that in economic activity the exchange processes between privately-owned factors of production cannot be sufficiently finely tuned to enable somebody to be better off without somebody else being made worse off. Hence socialist doctrine.

But knowledge is in a different category. Amongst scientists it is gifted and re-gifted with only mutual acknowledgement as reward (albeit an essential reward without which the social organisation of science would break-up). Only priority over the ownership of scientific knowledge is held sacrosanct, not ownership itself. It would seem, therefore, that the concept of trust ownership of intellectual property on behalf of society is a first base upon which can be built an ideology for scientists. But to construct such an ideology will require on the part of scientists the display of the highest standards of integrity and a pattern of behaviour outside the laboratory that must not reveal absurd inconsistencies or propensity to corrupt.

If we are serious about building a secular, democratic society of which the scientific enterprise is an organic part then scientists must establish their bona fides as trustees while society, through Parliament and government, must permit the mature criticism of public policy.*

---

* Specifically, it will call for the most liberal interpretation of the 'conduct rules' governing government servants. It would be preferable if altogether new 'rules' were written for the scientific component of the civil service.

... 16

Without such constant calibration we are liable to do irreparable damage to the fabric of society as it is woven by the complex interactions between Man and his environment. Society must also understand the internal social system of the scientific community (as outlined above) if it is to appreciate and assess the merits of the peculiar brand of mature advocacy that is scientific advice.

With such a mutual understanding between our scientists and our society we may make some progress towards erasing the dichotomy suggested in the Galbraithian title of this essay.

References

1/ Ravetz, J.R., Scientific Knowledge and its Social Problems, Oxford University Press, 1971 and Penguin Books, 1973. Etiquette in the literature on Science and Society is ill-defined. It is difficult to distinguish between what is attributable and what is derivative from an idea in common currency. Much of what appears in this essay has been fashioned from the ideas of Ravetz. I have also benefitted from conversations with a number of people. They include R.Narasimha and A.K.N.Reddy of the Indian Institute of Science; S.Ramaseshan and S.R.Valluri of the National Aeronautical Laboratory; A.Rahman of C.S.I.R. and P.M.Bhargava of the Regional Research Laboratory, Hyderabad. It was during a short but intense conversation with Derek J. de Solla Price in 1973 that I first realised that scientists in their community are not just the actors, they are the play.

2/ See for e.g.:Clark, Ronald, W., J.B.S., The Life and Work of J.B.S. Haldane, Coward McCann, 1968.

3/ See for e.g.:Feynman, Richard P., The Development of the Space-Time View of Quantum Electrodynamics, Physics Today, August 1966, pp. 31-34.

4/ Perhaps the most well-known of the works in this category is:Watson, James, D., The Double Helix: A personal account of the Discovery of the Structure of DNA, Weidenfield and Nicolson, 1968.

5/ Kuhn, Thomas, S., The Structure of Scientific Revolutions, Second Edition, The University of Chicago Press, 1970. See also the extensive discussion in:Lakatos, I., and Musgrave, A., Criticism and the Growth of Knowledge, Cambridge University Press (Reprinted), 1972.

6/ A fair amount has been written on the role of the scientific community in the shaping of the Science Policies, particularly in Big Science, of the western capitalist world. A most well-known account is: Greenberg, Daniel, S., The Politics of American Science, Penguin Books, 1969. One of the few studies of the influence of scientists on society in the socialist world and not so well-known is: Parry, Albert, The New Class Divided, Macmillan, London, 1966.

7/ Medawar, P.B., The Art of the Soluble, Methuen & Co., London (Reprinted), 1968.

8/ Ziman, John, M., Public Knowledge, Cambridge University Press, 1968.

9/ For an outstanding and fascinating exception see: Anderson, Robert, S., Building Scientific Institutions in India: Saha and Bhabha, Occasional Paper Series No. 11, Centre for Developing-Area Studies, McGill University, Montreal, 1975. Anderson's study is required reading for anyone wishing to understand the physiology of Indian Science Policy making. I am indebted to Geoffrey Oldham for a copy.

10/ Ravetz, J.R., Op. cit., p. 418.

11/ An Approach to the Science and Technology Plan, National Committee on Science and Technology, Department of Science and Technology, New Delhi, 1973; hereafter Approach.

... ii

12/ Op. cit., Section 2.2-1, p. 24

13/ Loc. cit.

14/ For some recent evidence of this, see for e.g. 'Technology Import to be tightened', Economic Times, 8 March 1976. As recommended in the Approach, Government has decided to exempt from industrial licensing units wishing to manufacture items resulting from R & D sponsored by them in approved laboratories. (Economic Times, 9 March 1976).

15/ See for e.g.: Reddy, Amulya Kumar N., Towards an Indian Science & Technology, Journal of Scientific and Industrial Research, Vol. 32, No. 5, May 1973, pp. 207-215.

16/ Still within the neo-keynsian paradigm, the Approach nevertheless refers to this obliquely thus: "R & D resources devoted to import-substituting the relatively sophisticated "metropolitan" technologies will, therefore, have a distinct "opportunity cost" in so far as R & D resources are not being devoted to other areas for which there is no market demand, though there is social and political demand. The distinction is between "demand" and "need"." Op. cit., Section 2.2-2, p. 27.

17/ Draft Science and Technology Plan, 1974-79, Vols. I and II, Government of India, National Committee on Science and Technology, New Delhi, August 1973.

18/ For some insights into the antecedents of this situation see: Parthasarathi, A., Appearance and Reality in Indian Science Policy, Nature, 8 March 1969.

19/ For a journalistic discussion of some of the complexities in the planning of defence research see my article: The Aeronautics Committee Report - a Critique, Economic and Political Weekly, Vol. IV, No. 35, Review of Management, August 30, 1969.

20/ Research and Development Statistics, 1973-74, National Committee on Science and Technology, Department of Science and Technology, New Delhi, May 1975.

21/ Phrase used in Notes and News, Science and Culture, February 1967, pp. 49-50. Quoted in Anderson, R., Op. cit., p. 113.

22/ See: Joan Robinson, Useless for any Practical Purpose, Economic & Political Weekly, February 28, 1976. pp. 361-2. The piece by a leading economist is a review with commentary of Ashok Rudra's book, Indian Plan Models, Allied Publishers, Bombay, 1975. For a rounded elaboration of why this is inevitably so, see: Brian Easlea, Liberation and the Aims of Science - An Essay on Obstacles to the Building of a Beautiful World, Chatto and Windus, London, 1973, particularly chapters 4 to 10. The book is a critique by a mathematical physicist and a not altogether unsuccessful attempt to provide the central connections between everything and everything else in the ordinary business of life!

23/ For an unconventional description of the bases of these cybernetic models see: Stafford Beer, Platform for Change, John Wiley, London, 1975.

... iii

24/ For an excellent review of the state of this Art see: Encel, S., Marstrand, Pauline, K., Page, W., (Eds.) The Art of Anticipation, Martin Robertson, London, 1975.

25/ Margaret Mead, Culture and Co mitment - A Study of the Generation Gap, The Bodley Head, 1970, p. xxi. "In history as in science . . . ."

26/ There is much quotable material that would be appropriate here but would take up too much space. I would urge the reading of the following editorials in different issues of Science (Journal of the American Association for the Advancement of Science): Edward E. David Jr., One-Armed Scientists ?, 29 August 1975; Kenneth E.Boulding, Truth or Power ?, 31 October 1975; Alvin M.Weinberg, Science in the Public Forum: Keeping it Honest, 30 January 1976; Gerald M.Edelman, Scientific Quests and Governmental Principles, 9 April 1976.

27/ Kosambi, D.D., Problems of science and technology in the present context of the evolution of the underdeveloped countries, in Rahman, A., and Sharma, K.D. (Eds.), Science Policy Studies, Somaiya Publications Pvt. Ltd., Bombay, 1974.

28/ The first serious Indian scientific journal with quality-control rather than communication as its main objective is now being published forty years after the first (and some would say last) high-quality research in physics was done in our country. For an eloquent statement of the raison d'etre of such a journal see: Ramaseshan, S., Editorial, Pramana, Vol. I, No. 1, July 1973. (Indian Academy of Sciences, Bangalore).

29/ But the task of setting a proportion is not altogether hopeless. See: Weinberg, Alvin, M., Criteria for Scientific Choice, Minerva, I (Winter 1963), 2, pp. 159-171 and idem, Criteria for Scientific Choice II: The Two Cultures, Minerva, III, 1 (Autumn 1964), pp. 3-14.

30/ Nag Chaudhari, B.D., Interfacing Science and Technology, Fifth B.C.Guha Memorial Lecture, reprinted in Rahman, A., and Sharma, K.D., Op. cit., p. 428.

31/ For a simple summary see: Diwakar, R.R., Gandhiji's Ideas of Trusteeship And Its Implications & The Eleven Vows of Gandhiji, Lectures on Gandhian Philosophy delivered at the Indian Institute of Science, Bangalore, 9-10 February 1968.