The Morality of Designing Nuclear Weapons[1]

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Nuclear weapons are unique – their impacts are primarily on innocent civilian non-combatants particularly women and children; they are intrinsically indiscriminate; they are largely uncontrollable; they are instruments of mass murder on a scale unparalleled in human history. Nuclear weapons have security, economic and political implications. In the ultimate analysis, however, the issue of nuclear weapons is a *moral* question. It is a question of right and wrong, good and evil, ethics. It is this ethical aspect of nuclear weapons, especially as it applies to the designing and manufacture of nuclear weapons, that is the focus of this essay.[3]

The only actual uses of nuclear weapons against civilian populations during a war were by the US in Hiroshima and Nagasaki in 1945. The mentality that went behind ordering and executing the bombardment of Hiroshima and Nagasaki cannot really be understood without the context of the large-scale violence of World War II. Apart from the sheer magnitude of the numbers of casualties caused during the entire war, there are two other important thresholds that were crossed during the war. The first was the fire bombing carried out by the Allies of cities like Dresden, Hamburg and Tokyo. These resulted in an unprecedented scale of destruction and were the first really major attacks against civilian populations during the war. The second, and perhaps equally important, was the Holocaust.

It was a visit to Poland in September 1999 that brought me into direct contact with the realities of the Holocaust and simultaneously intensified my opposition to the nuclear tests of May 1998. There, a World Energy Assessment meeting in Cracow enabled me to visit the infamous Nazi concentration camps of Auschwitz and Birkenau that are now preserved as museums.

During World War II, about 1.5 million innocent victims from all over Nazi-occupied Europe, overwhelmingly Jews, either went directly to their death in the gas chambers and crematoria at Auschwitz and Birkenau, or indirectly via the camps where they were held prisoners until they were too weak to labour.[4]

The tour of the camps left one with a completely unexpected feeling. The scale of human extermination was so enormous that one had to remind oneself, particularly because the camps have been unpopulated since 1944, that there used to be human beings there. Human belongings – toothbrushes, shoes and suitcases – were piled from floor to ceiling in huge rooms, a separate room for each item, but the aggregate was more reminiscent of factory inputs. Even the room full of human hair looked like raw material for an industry, in the Auschwitz case, the manufacture of tailor's lining cloth.

If Auschwitz was unbelievable, its neighbour Birkenau located 3 kms away, beggared the imagination. Birkenau was spread over 175 hectares with 300 buildings each capable of housing 1000 inmates. Birkenau was a scale-up from the pilot plant

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3 J. Bronowski, *Science and Human Values* (New York: Perennial Library, 1990) was a major contribution to the ethical aspects of nuclear weapons.

4 Primo Levi, *Survival in Auschwitz* (New York: Collier Books, 1961).

demonstration at Auschwitz with a peak of 20,000 prisoners to full-scale commercialisation of mass-murder technology at Birkenau with 100,000 prisoners in August 1944.

The powerful impression that persisted was of detailed engineering resulting in "the immense technological complex created…for the purpose of killing human beings." The meticulous organisation and rigorous management were characteristic of mega-industries, "gigantic and horrific factories of death". The main gate of Auschwitz displayed the inscription "Arbeit macht frei" ("Work brings freedom"). Perhaps a more apt announcement would have been "Technology completely decoupled from values".

As the scale of killing increases, the technology often, though not always, becomes more and more sophisticated – from knives to guns to machine guns to bombs to gas chambers and crematoria to atomic bombs. Also, with increasing scale, not only does the distance from victims become greater, but also the complexion becomes more and more technical. Burial is sufficient for one body, but for hundreds or thousands of bodies, the thinking has to be in terms of "throughput", "air/fuel ratios" and "burning capacity".

In Auschwitz, it is obvious that nothing happened spontaneously. Everything was deliberately designed and planned. The Nobel Prize winner, Fritz Haber, developed the poison Cyclon B. One of Germany's top chemical industries, IG Farben, produced the poison for exterminating people in the gas chambers. Careful experiments were done to determine the time that it would take for a person to be poisoned. An engineering firm designed the crematoria furnaces to process 350 bodies per day in Auschwitz I. So, there must have been engineers preoccupied with the technical problems. Perhaps, like Oppenheimer talking about nuclear weapons, some even thought that the problem and the solution were "technically sweet". Or, like the Indian Department of Atomic Energy scientist at the Kaiga debate in Bangalore in1989 who said: "Hiroshima provided us with a fortunate opportunity to study radiation effects!"

Once the problem was defined as eliminating hundreds and thousands of people per day, the Auschwitz solution was inevitable. But, who defined the problem and promulgated the order? By and large, it was the political decision-makers that defined the problem. There was a conference at Wannsee, a suburb of Berlin, on January 20, 1942, at which the Nazi leadership decided in less than two hours (before lunch!) on the "final solution" to exterminate the Jews. Ethnic superiority, racial/religious hatreds and fundamentalist views are well-known bases for decisions with far reaching destructive impacts on human beings.

Why was this definition of the problem, and the horrendous "solution" that was largely implemented, so widely accepted? There could be several reasons. The population had been inoculated against moral judgements so that there was a pervasive moral indifference. The informed were silenced and articulate dissidents became the first inputs to the camps. The media and journals were not allowed to reveal the truth. As a result, many citizens genuinely claimed ignorance as an excuse.[5]

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[5] Peter Schneider, "The Good Germans" *New York Times Magazine*, February 13, 2000 shows that there were many Germans who protected Jews in the midst of Nazi terror, thus challenging "the theory of mass guilt and deepening the culpability of the collaborators."

But the most serious "explanation" (or was it an excuse offered by officials after the war?) for the widespread acceptance of the problem is the plea of duty and the obligation to carry out orders. At the post-war tribunal in Nuremberg, Nazi officials defended themselves by pleading that they were just carrying out orders.[6] The judgement delivered at Nuremberg was unambiguous – a human being has to take full responsibility for the consequences of his/her actions and the excuse of obeying orders is inadmissible.

Apart from the above factors that operate in the case of officials and technical personnel, there is the additional device of taking a top-down macro view with arguments about national security, geopolitical compulsions, deterrence, etc being offered. In such a lofty macro view, numbers and statistics displace human beings. New proxy words dominate the discussions – "burning capacity" replaces "the number of corpses burnt", "kilotonnes yield" replaces "kilodeaths" and so on.

Functionaries, however, cannot avoid contact with the prisoners and victims to keep the system going.[7] What is overwhelming and astounding in Auschwitz and Birkenau is the unbelievable cold-bloodedness of the operation. It appears that the guards treated inmates inhumanly because they believed that the victims were sub-human and "things" rather than people. Once such a belief is propagated and accepted, anything goes – as in the growing number of examples of ethnic cleansing and genocide (native Americans, Hindus and Muslims in Partition, Rwanda, Bosnia, Kosovo and East Timor).

Walking through the scene of genocide in Auschwitz, one begins to think of historical parallels. In particular, one wonders whether there is a difference between the Nazi concentration camps and the development of the atomic bombs at Los Alamos, the test at Alamogordo and the bombing of Hiroshima and Nagasaki resulting in the virtually instantaneous annihilation of hundreds of thousands of civilians. Of course, the Allies in World War II were not driven by the racism of the Nazis, and they were not pursuing a final solution of extermination of any particular religious group. But with regard to the scale of killing, the recruitment of capable minds, the harnessing of science and technology,[8] the extent of organisation, the resort to effective management, and the choice of targets to maximise annihilation of Japanese civilians, the Manhattan project and its follow-up were like the concentration camps, in fact, even more horrendous in their impact.

Are there implications for India? Since May 1998, the country has witnessed the scientist-politician nexus underlying the nuclear tests at Pokhran, the use of national security arguments to advance party agendas and the self-serving jingoism of the scientists. Of even greater importance has been the silence of its journals with a few notable exceptions, the obfuscation of ugly reality and the virtual absence of intellectual dissent. Each of these phenomena deserves greater scrutiny.

After an initial silence on the subject (as if it never happened), the journal *Current Science* dealt with the tests in an interesting way. It discriminated between obviously correlated concepts by publishing kilotonne yields and suppressing kilodeath estimates. It publicised the official/government version of the "kilotonnes

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6 The Nuremberg trials were portrayed in the Hollywood movie *Judgement at Nuremberg* (1961) that starred Spencer Tracy as the judge trying Nazi judges.

7 Christopher R. Browning, Ordinary Men: Reserve Battalion 101 and the Final Solution in Poland (New York: Harper Perennial, 1998).

8 Some scientists perhaps hoped that the weapons would never be used and others even opposed the use of the weapons after they were developed.

yield" of the test bombs, but rejected estimates of the hundreds of thousands of innocent non-combatants who would be killed if even a primitive atomic bomb were exploded on Mumbai or Karachi.[9] This is a glaring example of the unpleasantness of discussing the mass annihilation of human beings being circumvented by altering the vocabulary of discourse. Thus, considerations of the kilodeaths that would result from nuclear explosions are evaded by focusing on discussions of kilotonnes yields, a seemingly innocuous term.

Further, with regard to the official/government estimates of the yield of the Pokhran II tests, what is noteworthy is not that they were published, but that counter views were not pro-actively elicited and revealed. In doing so, *Current Science* behaved like an official mouthpiece of the establishment, rather than as an independent journal like *Nature,* which acts as a forum facilitating discourse and discussion and encouraging scientists to express an opinion that is contrary to what is perceived as an accepted establishment view. Interestingly, though *Current Science* abdicated its responsibility of encouraging a scientific discussion of yields, *Frontline***,** which is a general magazine, initiated such a debate. In its November 27, 1999 issue, *Frontline* published an article by scientists from the nuclear establishment laying out their claims about the yields of the nuclear tests.[10] This was rebutted by an independent scientist in a subsequent issue.[11]

Viewing the Indian nuclear programme through the lens of the Holocaust raises other questions. Are the institutions on the Indian sub-continent necessarily more robust and moral than those in the Germany of the 1930s and 1940s? Are Indian politicians and parties less prone to exploit religious animosities? Are Indian scientists and engineers less eager to get political support for their next ego trip or power play?[12] Once the nuclear-tipped missiles are deployed, are there guarantees against "some crazy fool doing some crazy thing"? Is it certain that Pokhran will not lead as inevitably to Lahore and/or Chagai to Mumbai as Alamogordo led to Hiroshima?

The nuclear tests exposed the internal condition of Indian science. Faced with a complexity of issues raised by the tests – issues of (internal and external) security, trade and economics, politics, ethics, national traditions – it would have been natural for the body of intelligent and creative scientists to develop a spectrum of views. Instead, the virtually unanimous euphoria was astonishing. And, the silence of the present and past leaders of science, their academies and their journals was deafening. Since, it is statistically unlikely that almost the whole body of scientists had independently arrived at a single view, one has to probe deeper to find an explanation.

Free India started with the Nehruvian idea of science as an essential accoutrement of a modern society. Today, the nuclear tests have shown the determination of the rulers to make Indian Science a servant of the state and its internal and external political ambitions. The idea that science is the people's *astra*

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9 This was subsequently published as M. V. Ramana, Bombing Bombay, (Cambridge, USA: International Physicians for the Prevention of Nuclear War, 1999).

10 R. B. Attarde, V.K. Shukla, D.A.R. Babu, V.V. Kulkarni and Anil Kakodkar, "The Question of Nuclear Yield," Frontline, November 27, 1999.

11 M. V. Ramana, "The Question of Nuclear Yield," Frontline, January 8, 2000.

12 For example, P. K. Iyengar, a former Atomic Energy Commission chairman has called for India to develop a neutron bomb because they kill without destroying. See "India must test n-bomb before signing CTBT," The Hindu, 2 May 2000.

(weapon) against poverty is being jettisoned. The Jai Vigyan pronouncement symbolises this attempt by the government to co-opt scientists.

But, this is not an unrequited one-sided desire to embrace. In turn, scientists have been wooing the ruling establishment with a desperate desire to be in the corridors of power. When the Government kept them at an arm's length, as seems to have been the case in the Narasimha Rao regime, scientists seemed quite bitter and rejected. They even considered that period the nadir of post-Independence Indian science.

In contrast, the giants of Indian Science, in particular C. V. Raman and Meghnad Saha, considered their independence from government in the years immediately after 1947 to be a matter of pride. But, power was irresistible to the scientists who followed. And the only way this desire could be fulfilled was to woo government through its scientific ministries and their secretaries. Scientific academies courted secretaries of scientific ministries to be their presidents and office-bearers. There was no guilt or regret that, in the process, the academies lost their independence. Or, that their voices could not be distinguished from those of government. This lacuna is in a country where there are very few other institutions that are independent enough to come up with perspectives different from the government. In the West, the universities provide independent policy studies, but such independence is rare in India.

Thus, scientists wanted to be, and became, a pressure group. All this has become clear after the tests when the former Prime Minister Deve Gowda revealed how the nuclear scientists lobbied the Government to give them a chance to prove their capability. The scientists had not done a comprehensive cost-benefit analysis of the tests and their fall-out. Despite this, they pursued a narrow departmental, if not personal, agenda, perhaps emulating their political masters.

An understanding of science-society interactions in India has to take into account, on the one hand, the existence of a dual society, and on the other hand, its strong interaction with the industrialised countries. The coupling with the industrialised countries leads to the dominance of foreign-collaborating industry based on the import of technology, and the dual character of Indian society results in an overwhelmingly elitist thrust of indigenous technology. Further, even these indigenous technological efforts consist almost wholly of the imitation and adaptation of foreign technology, rather than of innovation.

This almost complete decoupling of science and technology from each other has a profound impact on science in India and produces its first major abnormality. Because of the preponderance of technology imports and of the imitative character of indigenous technology, the initial part of the innovation chain (consisting of research, design and development, and engineering-for- manufacturing) hardly exists in the country. As a result, its scientific system is not subject to the pressure of basic problems emerging from technology. And, without this pressure from technology, indigenous science is deprived of a powerful driving force. The vitality of science in a society depends upon the challenges thrown up by the innovation chain leading to technology as well as upon its internal momentum arising from the backlog of unresolved problems.

The pace or tempo of research activity depends upon the existence and maintenance of an atmosphere of excitement, which in turn requires a conviction of being “hot on the trail” of important discoveries. Such an atmosphere is facilitated by rapid communication between scientists through personal contacts, seminars, symposia and conferences and through well-referred journals which ensure quick

publication. The pace of research is usually set by outstanding scientists who attract a following. The point is that scientists tend "to hunt in packs" behind leaders.

The "mass" of scientists depends upon the size of the scientific body, but not merely upon the number of scientists. What is required is a *community* of *interacting* scientists with the well-established traditions of a peer system. Scientific peers are crucial for discussions, brain-storming and testing out ideas, for acquiring different ways of looking at a problem, for enhancing the quality of seminars, symposia and conferences, for rigorous assessment and constructive criticism of work, for help in improving its quality, for weeding out defective work, for a process of recognition that is appreciated, and so on. In short, without the environment of an actively interacting scientific community, there cannot be the natural selection of scientific ideas and data that alone will ensure that the fittest theories and experiments survive.

Natural selection of ideas implies competition and diversity. It cannot arise if there is a monoculture of views. Truth cannot emerge if there is an absence and/or exclusion of dissent, and certainly not, if dissenters are branded anti-scientific and anti-national.[13] It is against this background that one notes with regret that in recent decades there have not been major scientific controversies within the Indian scientific establishment. Bitter enmities between some leaders of Indian science are well known, but they are only mere conflicts of ambitions and careers; they are not conflicts on scientific issues. The only controversies that have arisen – the Bhopal gas disaster, the Sardar Sarovar project, nuclear power and so on – have seen participation only from scientists who are outside the establishment or those that are treated as renegades and ignored.

The standard way of avoiding genuine controversy and peer review is to exclude unorthodox views from seminars, committees, journals and other forums (including the peer-reviewing process). So, one finds internationally acclaimed experts not being invited to meetings on their subjects because they hold "unacceptable" views or they are not in the hierarchy. The dialectic of truth is frustrated even in so-called institutes of "advanced" studies. Of course, all this distortion of scientific tradition cannot survive if there were transparent democratic functioning. That is why there is a striking lack of transparency, undemocratic functioning and manipulation of peer review.

Underlying all this violation of the scientific tradition and its codes of behaviour is the fact "he who pays the piper calls the tune." Government and quasi-government sources are responsible for the overwhelming share of science funding so that scientific activity depends strongly on this funding, and almost all scientists are on the government pay-roll or perk-roll. There are also a number of cash-carrying prizes and awards that act as further inducements to conform, rather than dissent. No wonder there was a stampede of scientists to applaud the nuclear tests and prove their patriotism as perceived by the establishment. Fortunately, in spite of all this pressure for conformity, there were some scientists who dissented and their numbers grew with the waning of the initial euphoria.

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[13] Appreciation of the importance of dissent can be found in most unexpected quarters. The American Central Intelligence Agency has an officer in charge of "contrarian thinking" whose failure "to challenge the experts of the agency and other intelligence agencies" was the "key incident" that contributed to the "worst intelligence failure" in recent times of the US not predicting the Indian nuclear tests. See *The Hindu*, 5 July 1999.

With regard to the directions of Indian science, discussions must start with the country's poverty – for this is the country's defining characteristic and fundamental reality. In 1951, India's poor numbered 164 millions; in 1993-94, the number had increased to 312 millions, that is, double the number of people at Independence who could not meet their daily subsistence requirements. Between 1950-51 and 1993-94, the percentage of the population below the poverty line declined by less than 1% per year. One in three Indians go to bed hungry. Life expectancy is about 60. Half the Indian population cannot read or write. According to the 2000 Human Development Report of the United Nations Development Programme, India's Human Poverty Index (HPI) in 1998 was 35 %;[14] this index is a composite of *longevity* (19.4% of the population expected to die before the age of 40), *knowledge* (48.8% are illiterate), and *standard of living* (19% are without access to safe drinking water, 15% without access to health services and 53% of the children are malnourished or underweight). India belongs well and truly to the club of poorest nations. The country can move out of this cursed club only through sustainable development, not through nuclear explosions.

It is this Indian reality that must guide the direction of Indian science. Instead, what is observed is a lack of correspondence between the thrust of Indian science and the problems of the Indian people. Going by the expenditures on R & D, it appears that the bulk of the expenditure (about two-thirds) goes to the Defence Research and Development Organisation, Department of Space and Department of Atomic Energy, all of which have overt and/or covert military implications.[15] Of the balance, a large percentage goes to industrial research, but this caters largely to the needs of the elite. In fact, going by the militarist-elitist expenditure pattern of Indian R & D, one would think that the primary problems of Indian society concern external security and upper class consumption wants, rather than poor health, illiteracy and basic needs.

This mis-orientation of Indian science is not a surprise. It follows from the fact that the country consists of small islands of urban splendour amidst vast oceans of rural misery. This situation is often referred to as a "dual society" – a small politically powerful elite (constituting a mere 10-15% of the population and consisting of industrialists, landlords, bureaucrats, professionals and white-collar labour) living in conspicuous affluence amidst the abject poverty of the politically weak masses.

Scientists escape responsibility for the mis-direction of science by the clever excuse of the amorality and neutrality of science. Examples of this are the statements by Abdul Kalam that "he is only an engineer" and that his missiles "can also be used for delivering flowers".

The amorality and neutrality emerge from two conventional prescriptions for the relationship between the scientist (the subject) and the object of scientific study. Firstly, the scientist is urged to separate and distance himself/herself from the object of study even when the object is living. The second "commandment" for the scientist

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[14] The HPI is a measure of human poverty. It is composite index that measures, for the developing countries, deprivation in life expectancy, literacy and economic provisioning (access to health services, safe water and the percentage of children who are moderately or severely under-weight.

[15] According to Eric Arnett, the percentage of government funding for science spent on military, nuclear and space Research and Development was 68% in fiscal year 1996-97. See Eric Arnett, "Nuclear deterrence, nuclear tests and science in South Asia: Selected Statistics and Quotes," available on the internet at http://www.sipri.se The Government of India data for 1998-99 put this figure as 59% (Government of India, Union Budget, 1998-99, Expenditure Budget, Vol. II).

is to eschew feelings from the analysis so that the study is a cerebral non-subjective activity devoid of emotion and values. Thus, modern science has been based on two dichotomies: (a) separation of the subject from the object and (b) separation of feelings and emotion (the non-cognitive self) from thought and analysis (the cognitive self). However, the first dichotomy leads inevitably to degradation of the objects of study (even humans) into things, and the second, to the removal of feelings for objects (plants, animals and finally human beings of different castes, tribes, nationalities and religions). The amorality of science stems from this isolation of the subject from the object and this removal or absence of emotions and feelings and values. And when the object of the study includes human beings, then the perception of people as "things", lead inevitably to science becoming the instrument of violence, oppression and evil. Hence, the roots of the disjunction between science and morality go much deeper.

The submission here is that there is a way out of the moral dilemma. The relationship between the scientist (the subject) and the object of scientific study must be such that *initial separation* (and distance) ends in *subsequent unification* (and embrace). Further, the suppression of emotion *during* analysis must give way to emotion *after* analysis. The functioning of scientists as individuals, groups and institutions must be constrained and limited by moral strictures and taboos. Otherwise, the synergism between the isolation of the subject from the object and the removal or absence of emotions and feelings leads inevitably to science becoming the instrument of violence, oppression and evil. Science, therefore, must not be neutral and amoral. It can be – and must be – encoded with *life-affirming* values.[16]

From this standpoint, there are no life-affirming values associated with the nuclear tests and the attitude of the Government to weaponization. In fact, if there are any values at all, they are life destroying. And the Prime Minster's pronouncement of *Jai Vigyan* after the old slogan *Jai Jawan, Jai Kisan,* is tantamount to eulogising activities of science that can end up killing lakhs of non-combatants – children, women and men – in a nuclear attack. Such statements are only a ploy of the rulers to win over scientists to the militarization of Indian science. By going euphoric over science as an instrument of mega-death, the Government is sending a message commending the nexus between science and evil. The link between science and morality must be re-established.

A crucial safeguard is to insist that, quite apart from the top-down macro view of security, yields, kill-ratios, etc., there must be a bottom-up micro view based on human beings. We must see beyond the numbers and the statistics, we must see children and parents and grandparents, lovers and married couples, siblings, friends and comrades.

The nuclear tests and threat of weaponization have exposed the serious weaknesses of Indian science. They have shown that Indian science is responding more to the militaristic and consumption ambitions of the elite than to the problems of the poverty-stricken Indian masses. Rather than be a force that balances the demands of the state and civil society, the tests have revealed that Indian science has become a servant of the state whilst pressuring the state to advance the vested interests of Indian science and its scientists. The tests have revealed that the science-state nexus is strong. Indian science has betrayed the humanistic heritage left behind by Mahatma Gandhi and Lord Buddha. Sheltering behind the argument that science is amoral and

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[16] Thanks are due to Shiv Vishwanathan for this insight.

neutral, Indian science may become an instrument of violence, oppression and evil. It has not encoded itself with life-affirming values. Immediately after the nuclear tests, the majority of Indian scientists echoed the official line in a regimented fashion. They did not show the independence of perspective and diversity of views characteristic of a community of interacting scientists with the well-established traditions of science.

Is there hope for Indian science? Yes, and it is to be found in the voices of dissent that emerged from many scientific institutions after the nuclear tests.This has led to the formation of groups like the Indian Scientists Against Nuclear Weapons.[17] If these "nuclei" grow and coalesce, then there is hope for a "phase transformation" through which the character of Indian science will change. Then, the poor and the meek of India shall inherit the benefits of science. The state will be enriched by having a significant fraction of scientists reflecting independent views through the institutions of civil society. The morality of Indian science will become a tribute to the legacy of Gandhi and Buddha.

Now that the tests are over and weaponization is on the agenda, Indian scientists must move forward. They must stop (a) the jingoistic exploitation of the nuclear and missile programme by forces with short-term political interests, (b) the erosion of democracy, (c) the further diversion of scientific talent away from the problems of the poor towards military applications of science and an arms race with our neighbours. They must contribute to the process of international disarmament. And above all, they must turn their attention to the historic mission of giving all Indians – and particularly the underprivileged – a better life at least in the next century.

Scientists have several roles as intelligent people privileged with technical training:

- They must spread awareness of the enormous consequences of the path the government may choose from the nuclear option to tested weapons to deployed weapons to weapons on hair-trigger alert. For example, the effects of one primitive Hiroshima-type bomb on Bangalore or Chennai or Calcutta or Delhi must be estimated and publicised. And independent calculations must be made of the financial costs of the ruinous path the country is being urged to choose.
- They must build an independent peer group outside the establishment to verify the claims being made. Secrecy stifles independence, erodes excellence and breeds mistakes (and even lies!). For example, independent estimates of the costs of nuclear power have already revealed serious flaws in the costing carried out by the Department of Atomic Energy.[18] No wonder that secrecy is an important weapon used by insecure establishments to prevent rigorous peer review.
- They must reorient the thrust of Indian S & T. Unfortunately, this demand leads to the spotlight being turned on fundamental research, which is asked to justify its usefulness. But, fundamental research accounts for less than 10-15% of the total expenditure. This share should be given – no questions asked – to the fundamental scientists. In return, all that must be insisted upon is that they set up and implement rigorous quality control measures and strive for excellence. The

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17 http://www.freespeech.org/isanw/

18 Amulya K.N. Reddy, "Nuclear Power: Is it necessary or economical?", *Seminar* 370 June 1990, pp. 18-26; Amulya K.N. Reddy, Gladys D. Sumithra, P. Balachandra and Antonette D'Sa, "Comparative Costs of Electricity Conservation, Centralised and Decentralised Generation," *Economic and Political Weekly* 25, no. 22 (June 2, 1990), pp. 1201-1216.

real problem is applied research and technology, which consumes the bulk of the R & D funds. It must be carefully chosen to ensure that its thrust corresponds to the country's problems. That this is possible even under present conditions was proved by several governmental and autonomous institutions as well as non-governmental organisations in the late 1970s and the 1980s which evolved innovative efforts and methodologies to re-unite science and the people. And in the process it must not be forgotten that India is a dual society with a powerful elite and disempowered masses.

- Scientists must be involved in new coalitions of people opposed to the militaristic turn in the affairs of the nation. They must join forces with peace activists, development workers, environmentalists, women, dalits – in fact, all those who are concerned about the future.
- The Gandhi talisman must never be forgotten: "Recall the face of the poorest and most helpless person … and ask yourself if the step you contemplate is going to be of any use to him. Will he be able to gain anything from it? Will it restore to him control over his life and destiny?"