La Trahison des Clercs: Scientists and India's Nuclear Bomb[1]

M. V. Ramana

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The bomb cult … [is] the rebellion of the rebelled against, an insurgency of an elite.
Amitav Ghosh[2]

Introduction

Speaking at the 1971 annual meeting of the American Association for the Advancement of Science, Alvin Weinberg, then the director of the Oak Ridge National Laboratory, USA, called for setting up an elite 'priesthood' that would manage the nuclear energy enterprise.[3] In India, a similar priesthood was set up in the late forties by Homi Bhabha, a theoretical physicist and architect of India's nuclear program. Starting as a small scientific laboratory, the Indian nuclear establishment progressively moved onto becoming the creators of India's 'nuclear option' and, more recently, a nuclear arsenal featuring weapons with varying destructive capabilities. Together with the Defence Research and Development Organization (DRDO), the designers of the missiles that

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[1] The title is drawn from Julien Benda, *The Treason of the Intellectuals (La Trahison des Clercs)* (New York: W. W. Norton and Company, 1969); originally published in French in 1928.
[2] Amitav Ghosh, "Countdown," *Himal*, November 1998.
[3] Alvin M. Weinberg, "Social Institutions and Nuclear Energy," *Science*, 7 July 1972, 27-34. The choice of the term "priesthood" to describe nuclear engineers is appropriate in ways other than Weinberg intended. As Antonio Gramsci argued: "In the absence of [a sentimental connection], the relations between the intellectual and the people-nation are, or are reduced to, relationships of a purely

would carry these explosives to their targets, the nuclear establishment constitutes what Itty Abraham has aptly termed a 'Strategic Enclave'.[4] The pressure exerted by this strategic enclave has been an extremely important factor in India's quest for nuclear weapons and shaping nuclear and security policy.[5] In this chapter we will trace the history of the strategic enclave's involvement with the bomb in India and some prognosis of the future. Then we briefly chronicle opposition to nuclear weapons and militarisation on the part of Indian scientists. We first start with a quick overview of the involvement of scientists around the world in making nuclear weapons and defence policy, a short discussion of the political economy of science, and a brief overview of the sociological factors specific to the scientific community in India.

Scientists and Nuclear Weapons: Some General Aspects

Starting with the Manhattan project, scientists, in particular physicists, have been seen as the makers of the bomb.[6] Given the prominence accorded to scientists, it should

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bureaucratic and formal order; the intellectuals become a caste, or a priesthood." See Antonio Gramsci, *Selections from the Prison Notebooks* (New York: International Publishers, 1971), p. 418.

[4] "The guided missile and nuclear programs in India… constitute a 'strategic enclave.' This enclave is defined as a subset of the Indian military-security complex – specifically, the set of research establishments and production facilities that are responsible for the development of these new programs. It is 'strategic' because the end product of the efforts forms the most advanced technological means toward the goal of national security and represents the currency of international prestige and power today. It is an 'enclave' because institutionally, spatially and legally, the high-technology sectors of space and nuclear energy are distinct and different from the existing structure of the Indian military-security complex." Itty Abraham, "India's 'Strategic Enclave': Civilian Scientists and Military Technologies," *Armed Forces and Society* 18, no. 2 (Winter 1992), p. 233.

[5] See for example George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Berkeley: University of California Press, 1999), pp. 458-459.

[6] There is, of course, a difference between science and technology, and the vast majority of work that goes on in designing and manufacturing nuclear weapons would fall under the rubric of technology than science. Nevertheless, we use the terms science and scientists in a generic fashion without distinguishing them from technology for three reasons. First, public pronouncements about the bomb often portray it as a triumph of science rather than as an expression of technological prowess. Following the 1998 nuclear tests, practically all political parties showered praise on "our scientists" rather than "our engineers"; Prime Minister Vajpayee, in fact, added *Jai Vigyan* (Hail Science) to the old slogan from the

not be surprising that they have had an enormous influence, in different capacities, on nuclear policy around the world. This influence has been best studied in the case of the United States.[7] For the most part, what is available in the case of other countries that have developed nuclear weapons are general histories from which the role of scientists can be inferred.[8]

Among scientists the bombing of Hiroshima and Nagasaki led to two opposite reactions.[9] On the one hand, there was greater concern among scientists about the results of their activities and what uses it was put to by the state.[10] On the other hand, scientists were also seduced by the enormous increase in access to power that came about if they played along with, or better still, drove the state's obsession with using the latest technological devices for militaristic purposes.[11] As Solly Zuckerman argued: "In the changed relationship between science and military affairs that has prevailed since the Second World War, the military man has never ceased to urge the scientist to intensify

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1962 war with China: *Jai Jawan, Jai Kisan* (Hail the Soldier, Hail the Farmer). Thus, in public consciousness, the makers of nuclear weapons are identified as scientists rather than engineers. Second, more often than not, the leaders of nuclear weapons programs around the world have been physicists rather than, say, engineers. Third, a substantial portion of the actual technical work done to develop a bomb can legitimately be considered scientific, including, for example, modeling the neutronics as a function of time or calculating the intensity of radiation pressure.

[7] See for example Robert Gilpin, *American Scientists and Nuclear Weapons Policy* (Princeton: Princeton University Press, 1962); Lawrence Badash, *Scientists and the Development of Nuclear Weapons: From Fission to the Limited Test Ban Treaty 1939-1963* (Atlantic Highlands: Humanities Press, 1995); and Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca: Cornell University Press, 1999). There are few similar studies about scientists in other nuclear weapon states.

[8] See for example: David Holloway, *Stalin and the Bomb* (New Haven: Yale University Press, 1994); Margaret Gowing, *Independence and Deterrence: Britain and Nuclear Energy, 1945-1952* (London: Macmillan, 1974); Laurence Scheinman, *Atomic Energy Policy in France under the Fourth Republic* (Princeton: Princeton University Press, 1965); John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1988); and Avner Cohen, *Israel and the Bomb* (New York: Columbia University Press, 1998).

[9] Robert Jay Lifton and Greg Mitchell, *Hiroshima in America: A Half-Century of Denial* (New York: Avon Books, 1995), p. 251.

[10] Alice Kimball Smith, *A Peril and a Hope: The Scientists' Movement in America 1945-47*, 2nd ed., (Cambridge, U.S.A.: M.I.T. Press, 1970).

the technological exploitation of his knowledge in order to improve the armoury of available weapons; and within the economic restraints set them, the scientist and engineer have been only too ready to oblige, to the full extent of their abilities."[12]

An example of how scientists not only obliged, but in fact actively promoted the application of science to military uses comes from the United States during the First World War. In 1916, upon instigation by George Ellery Hale, a distinguished astronomer and foreign secretary of the prestigious National Academy of Sciences (NAS), a delegation of scientists met with President Wilson. The meeting resulted in the setting up of the National Research Council (NRC), in secret, with the objective of encouraging pure and applied research for "national security and welfare." Hale's own reasons for this initiative resulted from his earlier experience as a student in Europe where he had learnt the lesson: "to accomplish great results," scientists had to "enjoy the active cooperation of the leaders of the state."[13]

Regardless of the actual percentages of scientists supporting or opposing such developments, there is little doubt that by and large it is such scientists who supported the application of science and technology to militaristic purposes that have wielded greater influence on government policy. To understand why scientists espouse such goals requires an examination of the political economy of science as well as the role that the state would like scientists to play.

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[11] See for example Bruno Vitale, "Scientists as Military Hustlers," *Issues in Radical Science* (London: Free Association Books, 1985), pp. 73-87.
[12] Solly Zuckerman, *Scientists and War: The Impact of Science on Military and Civil Affairs* (London: Hamish Hamilton, 1966), p. 29.
[13] Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (Cambridge: Harvard University, 1995), p. 111.

Science is often seen as 'neutral' and detached from the forces that rule our everyday lives. But science, like all productive activities, is a social activity strongly influenced by social and political structures around it.[14] Because it is a human productive activity that takes time and money, science is guided by and directed by those forces in the country, or the world, that have control over money and resources. People earn their living by science – so the dominant social and political forces that fund this activity determine to a large extent what science studies and what the results of such studies are used for.

The most obvious reason why science is funded is because of its connection with technology and the production of new artifacts that benefit society in general, and the funding agencies in particular. Among such artifacts that the state, which is a major source of science funding everywhere – and, in many countries including India, practically the only source of funding – desires are weapons. One characteristic of modern states is that they "possess the material and organizational means of waging industrialized war."[15] To obtain these means, they have invested heavily in science and technology.

In addition to this task, the state and dominant forces would also like scientists, and more generally intellectuals, to say and do things that legitimize and strengthen the existing social order. Though authors like Julien Benda have railed against this "treason of the intellectuals",[16] intellectuals have by and large performed this task willingly. In the

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[14] This formulation draws on Richard Lewontin, *Biology as Ideology* (New York: Harper Collins, 1992).
[15] Anthony Giddens, *The Nation-State and Violence* (Berkeley and Los Angeles: University of California Press, 1987), p. 293.
[16] Julien Benda, *The Treason of the Intellectuals (La Trahison des Clercs)*.

case of India, where the bulk of financial support for science came directly or indirectly from the state, it has been argued that science, through its association with "freedom and enlightenment, power and progress," contributed in a major way to the Indian state's efforts at legitimizing itself.[17]

The above-mentioned factors represent the "structure" under which scientists operate. However, in its day-to-day functioning as well as in how the truth-value and validity of scientific theories, models and experiments are determined, the scientific community has considerable autonomy.[18] Further, political elites depend on scientists to inform them of the implications of the advances in science. Therefore, scientists – and here the conflicts between different fields and different approaches within each individual field come to the fore – can choose to term one area of research as promising and call for greater support. In short, scientists also have "agency" in shaping the course science takes. But as the earlier discussion pointed out, there are strong constraints placed on this autonomy.

It is important to distinguish this formulation from more extreme criticisms of science that question the ontological and epistemological basis of the discipline. While social, economic and political factors do determine what kinds of science get privileged, they do not affect the subject matter of science, the "objective world." For example, American research in the 1940s and 1950s on quantum electronics was motivated in large

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[17] Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton: Princeton University Press, 1999), p. 3.
[18] It has been argued that this "independence" or "detachment" makes science seem objective and authoritative, giving it the legitimating power that makes science a resource for the state. Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press, 1989), p. 191.

part by potential military applications.[19] However, as Alan Sokal points out, these motivations or other extraneous factors have no effect on the underlying scientific question of whether atoms really do behave according to the laws of quantum mechanics.[20] There is a substantial body of convincing evidence that support the belief that the behaviour of atoms can indeed be described by quantum mechanics.

Factors Specific to India

In the context of Indian nuclear policy, historically there have been both elements of continuity and rupture. At the level of setting up the necessary infrastructure and the activities of the scientific and technological establishment one can discern continuity and a steady progression over the decades. This continuity is possible because nuclear scientists have been able to pursue programmes that diverge in subtle ways from proclaimed policy; this ability, in turn, is related to the structure of nuclear policy making and implementation in India. Unlike most policy matters where the cabinet has the ultimate authority, the agency in charge of nuclear affairs is the Atomic Energy Commission, which was constituted under a special act of parliament, and is composed primarily of scientists and dominated by the top leaders of the Department of Atomic Energy (DAE). The DAE was set up in 1954 under the direct charge of the Prime Minister. In addition to the head of the DAE, it has "been a tradition for several years to have the Principal Secretary to the Prime Minister, the Cabinet Secretary, Chairman & [managing director of the] Nuclear Power Corporation and Director, Bhabha Atomic

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[19] Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical and Biological Sciences* 18 (1987), pp. 149-229.

Research Centre (BARC) as members of the AEC."[21] Further, the structure of the DAE is hierarchical and not conducive to open dissent. Thus, even if junior scientists had qualms about working on some project, they would have few alternatives. In addition there are no institutions outside of the DAE that work on nuclear technology. With one exception, no university does research or offers a degree in nuclear engineering. Nuclear scientists, therefore, have no alternative to working in the DAE. This resulted in a situation where the "majority of workers and administrators in the scientific establishments play only a marginal role."[22]

Added to this is the fact that the DAE, like the larger scientific community in India, has had relatively few notable accomplishments. There have been, for example, no Nobel Prizes awarded to any scientist for work conducted in post-independence India. An important study of the scientific community in India found that most scientists were troubled by the marginal position of scientific activity in India in general, and of their own scientific research in particular.[23] The lack of relevance, perceived or real, of scientific research to the actual problems of India further accentuates the peripherality of scientists and results in widespread demoralisation. The shrill rhetoric, especially on the part of the nuclear and missile establishments, about self-sufficiency and indigenous development is indicative of the desire for wider recognition. Building nuclear weapons and thereby being seen as serving a national priority by the elite has, therefore, been an

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[20] Alan Sokal, "What the *Social Text* Affair Does and Does not Prove," in *A House Built on Sand: Exposing Postmodernist Myths about Science*, ed. Noretta Koertge (Oxford: Oxford University Press, 1998).
[21] "Atomic Energy Commission," available on the internet at http://www.dae.gov.in/aec.htm.
[22] Ashok Kapur, "India: The Nuclear Scientists and the State, the Nehru and Post-Nehru Years," in *Scientists and the State: Domestic Structures and the International Context*, ed. Etel Solingen (Ann Arbor: The University of Michigan Press, 1994), pp. 209-229.

answer to the larger failure on the part of the DAE to either produce world class science or provide cheap and reliable electricity.

While, as mentioned earlier, there has been continuity in some aspects of Indian nuclear policy, at the level of doctrine there have been sharp differences between different governments across the years.[24] These differences influenced and were influenced by middle class and elite perceptions, both of nuclear weapons and, more generally, of India's position and role in the world. One of the clear discontinuities or ruptures is the difference between the "official nationalism" of the Nehruvian period and that of the contemporary *Hindutva* moment.

During the Nehruvian phase, the attempts to consolidate society and to fashion a national identity produced an "official nationalism" (generally upheld by the state and its directing personnel).[25] Given the elite notion that Indian independence was to lead to India finding its rightful place in the world, it was not surprising that it adopted a particular "big vision". Accordingly, postcolonial state-formation privileged "Big Science, Big Development, Big Projects, and Big Goals". This vision continues to be prevalent. Absent during the Nehruvian era, however, was a role for "Big Weapons"; in other words, it was not a route to greatness through the acquisition of massive destructive capability.

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[23] V. Shiva and J. Bandyopadhyay, "The Large and Fragile Community of Scientists in India," *Minerva* 18 (1980), pp. 575-594.
[24] Praful Bidwai and Achin Vanaik, *South Asia on a Short Fuse: Nuclear Politics and the Future of Global Disarmament* (New Delhi: Oxford University, 1999), p. 235.
[25] Achin Vanaik, "Ideologies of the State: Social-Historical Underpinnings of the Nuclearization of South Asia" (paper presented at workshop on Nuclear Understandings: Science, Society and the Bomb in South Asia, Dhaka, Bangladesh, February 17, 2000). On "official nationalism" see Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1983).

The rise of Hindu nationalism or *Hindutva* in recent years is due to a new "elite insecurity" arising from the increasing social and political assertion of marginalized groups and the uncertainties associated with economic liberalization.[26] *Hindutva's* answer to this is a quest for "international status", through the deployment of symbolic gestures of "great power status" such as the ability to acquire and test nuclear weapons. The May 1998 tests, or for that matter the destruction of the *Babri Masjid*, a 16th century mosque, in 1992, are acts that demonstrate how it envisions making India "strong".

The leaders of the various institutions comprising the strategic enclave are certainly part of the elite, and their views are shaped by these shifts in official ideology. In fact, these leaders were more than sensitive to such shifts so as to advance their respective institutional interests. While individual leaders did have their own personality traits and priorities, their actions are strongly constrained by the structural details explained above and their positions as heads of institutions. It is in this light that one must read the history of the involvement of scientists with the bomb in India.

History

Perhaps the first important event in the setting up of the Indian nuclear programme was a letter written by Homi Bhabha in March 1944 to the Sir Dorab Tata Trust, requesting funds to set up a research institute. In his letter, Bhabha promised: "When Nuclear Energy has been successfully applied for power production in say a couple of decades from now, India will not have to look abroad for its experts but will

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[26] Achin Vanaik, "Ideologies of the State: Social-Historical Underpinnings of the Nuclearization of South Asia."

find them ready at hand."[27] These experts were to form the priesthood that managed nuclear affairs.

The institution of the Indian Atomic Energy Commission (AEC) in early 1948, barely a few months after independence, speaks to Bhabha's influence and the prominence accorded by Jawaharlal Nehru, India's first Prime Minister, to the atomic energy enterprise. The bill enabling this was introduced at the Constituent Assembly by Nehru and made atomic energy the exclusive responsibility of the state.[28] Modelled on Britain's Atomic Energy Act, the act imposed even greater secrecy over research and development than did either the British or American atomic energy legislation.[29] Nehru gave two reasons for the imposition of secrecy. "The advantage of our research would go to others before we even reaped it, and secondly it would become impossible for us to cooperate with any country which is prepared to cooperate with us in this matter, because it will not be prepared for the results of researches to become public."[30]

To say that the US, Canada, England and so on, from whom India got much of its early nuclear know-how, would steal ideas from Indian research is disingenuous at the very least. Further, it is not clear why "others" should not benefit from "our research". India, after all, was planning to benefit from the results of research carried out by western countries. But, in the post-independence milieu, such questions never arose at the Constituent Assembly. Neither were questions raised about the appropriateness of

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[27] G. Venkatraman, *Bhabha and his Magnificent Obsessions* (Hyderabad: Universities Press, 1994), p. 141.
[28] Itty Abraham, "Towards a Reflexive South Asian Security Studies," in *South Asia Approaches the Millenium: Reexamining National Security*, ed. Marvin G. Weinbaum and Chetan Kumar (Boulder: Westview Press, 1995), pp. 17-40.
[29] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 18.
[30] Shyam Bhatia, *India's Nuclear Bomb*, p.85

choosing nuclear energy as the path to India's development. As Zia Mian's nuanced analysis makes clear, the tone set by Nehru's arguments for investing in the programme precluded any such doubts.

> Nehru argued that by not having developed steam power and having thus missed out on the industrial revolution, India became a backward country. And what was the expression of that backwardness? In a clear reference to colonialism, he said, "it became a slave country because of that." The connection to atomic power became obvious. Nehru argued "the point I should like the House to consider is this, that if we are to remain abreast in the world as a nation which keeps ahead of things, we must develop this atomic energy."[31]

But Nehru could not prevent censure on another count. At least one member of the assembly, Krishnamurthy Rao from Mysore, strongly criticized the secrecy provisions in the bill.[32] Though he claimed to support the act, Rao asserted that the bill did not allow for the oversight and the checking and balancing mechanisms contained in the US Atomic Energy Act. He also pointed out that in the bill passed by the British, secrecy is restricted only to defence purposes and demanded to know if in the Indian bill secrecy was insisted upon even for research for peaceful purposes.

Nehru's response to this is surprising for someone who has spoken so eloquently about the peaceful uses of nuclear energy. He said: "I do not know how to distinguish the two [peaceful and defence purposes]." Nehru's dilemma is clear from his statements while introducing the bill. On the one hand he said "I think we must develop it for peaceful purposes." But he went on, "Of course, if we are compelled as a nation to use it

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[31] Zia Mian, "Homi Bhabha killed a Crow," in Zia Mian and Ashis Nandy, *The Nuclear Debate: Ironies and Immoralities* (Colombo: Regional Centre for Strategic Studies, 1998), p. 12.

for other purposes, possibly no pious sentiments will stop the nation from using it that way." Barely two years after the wholesale destruction of Hiroshima and Nagasaki, the "other purposes" were obvious.[33]

Within the AEC itself, it was clear that the commission was created not only to generate nuclear electricity; its aims were explicitly to develop "atomic energy for *all purposes*."[34] (emphasis added) M. R. Srinivasan, who headed the DAE in the 1980s, explicitly states the view within the commission: "[N]uclear technology was developed by a country to be solely available for its own benefit, whether for peaceful purposes or for military applications."[35] Since the AEC fell directly under the direct personal oversight of the Prime Minister, which in practical terms meant that the head of the DAE called the shots, the DAE operated with no controls whatsoever.

The DAE's plans for the nuclear programme were ambitious and envisaged covering the entire nuclear fuel cycle. Despite the rhetoric of indigenous development that pervaded, Bhabha and other leaders approached and accepted technical and financial aid from several countries such as the US, Britain and Canada.[36] *Apsara,* the first Indian reactor, for example, was based on a British design and used fuel rods manufactured in Britain. Likewise, it was an American firm, Vitro International, which was awarded the contract to prepare blueprints for the first reprocessing plant at Trombay. Between 1955

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[32] Itty Abraham, "Towards a Reflexive South Asian Security Studies."
[33] Zia Mian, "Homi Bhabha Killed a Crow," p. 12.
[34] Raja Ramanna, *Years of Pilgrimage* (Delhi: Viking, 1991), p. 60.
[35] M. R. Srinivasan, "India's Atomic Adventure," *Frontline*, 15 August 1997, p. 142.
[36] The word indigenous was often applied to even minor modifications of imported systems. One ironic example of this practice is Abdul Kalam's description of an effort at reverse-engineering a Russian rocket-assisted take-off system as "indigenous development." See A P J Abdul Kalam with Arun Tiwari, *Wings of Fire: An Autobiography* (Hyderabad: Universities Press, 1999), p. 51

and 1974, 1,104 Indian scientists were sent to various US facilities; 263 were trained at Canadian facilities prior to 1971.[37]

Central to the effort to create the wherewithal to produce nuclear weapons was the second research reactor, CIRUS, a 40 MW heavy water moderated, light water cooled, natural uranium fuelled reactor using the same design as the NRX reactor at Chalk River in Canada.[38] Canada supplied the reactor as part of its Colombo plan – a plan that was, in the words of Robert Bothwell, "premised on the relation between misery and poverty and communism."[39] Initiated by Nik Cavell, administrator of the Colombo plan, the idea of donating a reactor to India was supported by W. B. Lewis, head of AECL, Canada, and a fellow student of Bhabha's at Cambridge. The occasion for the announcement of the gift was the 1955 Geneva conference on the peaceful uses of atomic energy. Following shortly after the 1953 Atoms for Peace initiative by Eisenhower, the conference was the scene of much cold war era maneuvering as well as an opportunity for countries to exhibit their nuclear wares and woo potential customers.[40]

A few Canadian diplomats realized that this could lead to potential acquisition of weapons useable plutonium by India. After all the NRX was an efficient producer of plutonium because of its high neutron economy. Nevertheless the initiative went through because it was assumed that India would be able to acquire a reactor from some other

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[37] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 30, 482.
[38] W. B. Lewis and H. J. Bhabha, "The Canada-India Reactor: An Exercise in International Co-operation," in *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy* vol. 1, *Progress in Atomic Energy* (Geneva: United Nations, 1958), pp. 355-358. CIRUS stands for Canadian Indian Reactor; the US was added later on when the USA supplied heavy water for the reactor.
[39] Robert Bothwell, *Nucleus: The History of Atomic Energy of Canada Limited* (Toronto: University of Toronto Press, 1988), pp. 350-371
[40] See for example the description in Peter Pringle and James Spigelman, *The Nuclear Barons* (New York: Holt, Rinehart and Winston, 1981), pp. 165-178

source. Despite consistent efforts on the part of the Canadians, India, led by Bhabha, adamantly refused to accept any kind of voluntary controls or safeguards on the spent fuel produced.[41]

The ostensible reason for this refusal was the three-phase nuclear power programme for India that Bhabha had put forward. This programme involved separating plutonium from the spent fuel produced in natural uranium reactors and setting up breeder reactors, which in turn could be used to utilize India's vast resources of thorium for energy production.[42] Separated plutonium, therefore, was an essential requirement. The leap of logic that was put forward was that the imposition of safeguards would disallow plutonium acquisition. Hence, safeguards were considered unacceptable.

It is worth clarifying that there is no *a priori* reason why the imposition of safeguards would prevent the development of a breeder program. For example, the Japanese breeder programme runs fully under international safeguards. The more obvious and honest reason for opposing safeguards by Bhabha and subsequent leaders is the insistence on keeping the bomb option open, right from the inception of the nuclear program. But with practically no one in the country outside of the Atomic Energy establishment familiar with nuclear technology, questions about the proffered excuse were never raised.

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[41] Ruth Fawcett, *Nuclear Pursuits: The Scientific Biography of Wilfrid Bennett Lewis* (Montreal & Kingston: McGill-Queen's University Press, 1994), pp. 110 – 114.

[42] See for example H. J. Bhabha and N. B. Prasad, "A Study of the Contribution of Atomic Energy to a Power Programme in India," in *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy* vol. 1, *Progress in Atomic Energy* (Geneva: United Nations, 1958), pp. 89-101. A careful assessment shows that the breeder reactor programme is not likely to contribute significantly to India's electricity needs; see Rahul Tongia and V. S. Arunachalam, "India's Nuclear Breeders: Technology, Viability and Options," *Current Science* 75, no. 6 (25 September 1998), pp. 549-558.

When it suited his purposes, however, Bhabha also accepted safeguards. Examples of this are the reactors at Tarapur (TAPS I and II) and Rawatbhata (RAPS I and II). Bhabha's speech in 1956 at a conference on the International Atomic Energy Agency's statute makes clear the strategy he adopted. "[T]here are," Bhabha said, "many states, technically advanced, which may undertake with Agency aid, fulfilling all the present safeguards, but in addition run their own parallel programmes independently of the Agency in which they could use the experience and know-how obtained in Agency-aided projects, without being subject in any way to the system of safeguards."[43] Thus, India would use international assistance to further its weapon and civilian applications of nuclear power.

At the same time as these developments were occuring, the fifties also marked Nehru determined pursuit of global nuclear disarmament. Prominent among his initiatives was the Comprehensive Test Ban Treaty (CTBT).[44] Nehru also supported the activities of the international peace movement, in particular British philosopher-mathematician Bertrand Russell's initiative to foster contact between American and Soviet scientists. For a time, it seemed that the Indian government would sponsor what eventually became the Pugwash conferences.[45] New Delhi was in fact chosen as the first conference site and in June 1956 Russell dispatched invitations for a conference there in January 1957.[46] That was not to be. As Russell lamented: "[Nehru] had been exceedingly friendly. But when I

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[43] Statement by H. J. Bhabha at the Conference on the IAEA Statute, 27 September 1956, reprinted in J. P. Jain, *Nuclear India* vol. 2, (New Delhi: Radiant Publishers, 1974), pp. 39-49.
[44] Statement in the *Lok Sabha*, 10 May 1954, reprinted in *India and Disarmament: An Anthology of Selected Writings and Speeches* (New Delhi: Government of India/Ministry of External Affairs, 1988), pp. 33-37.
[45] Lawrence Wittner, *The Struggle Against the Bomb*, vol. 2, *Resisting the Bomb* (Stanford: Stanford University Press, 1997), p. 100.
[46] Lawrence Wittner, *The Struggle Against the Bomb*, vol. 2, *Resisting the Bomb*, p. 34.

met Dr. Bhabha, India's leading official scientist, I received a cold douche. He had profound doubts about any such manifesto, let alone any such conference as I had in mind for the future (Pugwash). It became evident that I should receive no encouragement from Indian official scientific quarters."[47] Not a single Indian nuclear scientist signed the famous Russell Einstein manifesto.[48] Nehru, however, set up an official group to study the effects of nuclear explosions at Russell's suggestion.[49]

Balancing this concern of Nehru's in nuclear disarmament was Bhabha's interest in and awareness of weapons technology. As early as 1959, he told the Parliamentary Consultative Committee on Atomic Energy that India's atomic energy programme had progressed to the point where it could make atomic weapons without external aid if called upon to do so.

More revealing is George Perkovich's account of a private meeting in 1960 between Nehru, Bhabha and an American military engineer, K. D. Nichols. After his 45 minute presentation about the advantages of American reactors, Nehru, according to Nichols, turned to Bhabha and asked him if he could develop and atomic bomb and how long it would take him to build it. Bhabha replied that he could do it in about a year. Upon which Nehru turned to Nichols and asked him if he agreed with Bhabha. An astonished Nichols replied in the affirmative. Whereupon Nehru turned to Bhabha and said: "Well, don't do it till I tell you to." With the benefit of hindsight, and perhaps the

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[47] Bertrand Russell, *The Autobiography of Bertrand Russell*, vol. 3 (London: Allen & Unwin, 1969 ed.), p. 80; Cited in Dhirendra Sharma, "Politics of the Atomic Energy," *Philosophy and Social Action* 24, no.3 (1998).
[48] Dhirendra Sharma, "Science and Control: How Indian Atomic Energy Policy Thwarted Indigenous Scientific Development," in *The Revenge of Athena: Science, Exploitation and the Third World*, ed. Ziauddin Sardar (London: Mansell Publishing, 1988), pp. 73-80.
[49] Lawrence Wittner, *The Struggle Against the Bomb*, vol. 2, *Resisting the Bomb*, p. 100.

scepticism that comes easily to anyone who examines the Department of Atomic Energy's record, Perkovich also notes that Bhabha's claim had "no basis in fact".[50] Even under the most optimistic assumptions a bomb could not have been made before 1963.[51]

The 1962 Indo-China war marked an early successful public attempt at integrating the nuclear enterprise with national security when Bhabha offered the services of the Atomic Energy Establishment at Trombay (now the Bhabha Atomic Research Centre) to help with defence systems. He also canvassed with the government and set up an Electronics Committee with himself as the chairman.[52] Political authorities were certainly favourable to this kind of nexus between science and military affairs. As early as 1946, Jawaharlal Nehru stated, "Modern defence as well as modern industry require scientific research both on a *broad* scale and in *highly specialised ways.* If India has not got highly qualified scientists and up-to-date scientific institutions in large numbers, it must remain a weak country incapable of playing a primary part *in a war.*" (emphases added) Scientists and their institutions were thus portrayed as crucial components of the state in peace and especially in war.[53]

The year 1962 also marked the adoption of a revised Atomic Energy Act by the parliament. The act significantly tightened secrecy and the AEC's control over all activities related to atomic energy. What was also significant, as Itty Abraham notes, was

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[50] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, pp. 36-37.
[51] Leonard Beaton and John Maddox, *The Spread of Nuclear Weapons* (London: Chatto & Windus, 1962), pp. 138 - 140; cited in W. P. S. Sidhu, "The Development of an Indian Nuclear Doctrine since 1980," (Ph.D. dissertation, Emmanuel College, Cambridge University, 1997).
[52] G. Venkatraman, *Bhabha and his Magnificent Obsessions*, p. 172.
[53] Jawaharlal Nehru, "Defence Policy and National Development," note of 3 February 1947, in *Selected Works of Jawaharlal Nehru* vol. 2, Second Series (Delhi: Jawaharlal Nehru Memorial Fund) p. 364; cited in Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State* (London and New York: Zed Books, 1998), p. 49.

that neither the act nor the debate that took place in parliament when introducing the act did not, for the most part, mention the by then traditional focus on "peaceful uses".[54] Tacitly, the connection between nuclear power and national security was being elevated.

Three events mark the shift in India's nuclear programme during the next few years. The first was the death of Jawaharlal Nehru. While encouraging the development of a militarily capable nuclear infrastructure, Nehru had always opposed explicit weaponization. As late as 1957, when speaking at the Lok Sabha, Nehru declared that in no event would India use nuclear energy for destructive purposes.[55] During his tenure as the Prime Minister, there was only one instance when a parliamentarian ever called for the development of nuclear weapons. This was Ramachandra Bade, a member of the Jan Sangh, the precursor to the current BJP, who wanted the development of nuclear weapons to counter Russia and China.[56] The second event was the first Chinese nuclear test in 1964, barely two years after India lost the war with China. Third was the completion of a reprocessing plant at Trombay in 1964, which, along with the CIRUS reactor that became critical in July 1960, gave India the ability to extract plutonium and thus to make nuclear weapons.

By the time of the Chinese test, Bhabha had, for all practical purposes, began a public, though sometimes indirect, campaign for developing nuclear weapon capability. The campaign consisted of three elements. First, in response to one of the main objections against building nuclear weapons, Bhabha made exaggerated claims about

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[54] Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*, pp. 114-120.
[55] Praful Bidwai and Achin Vanaik, *South Asia on a Short Fuse: Nuclear Politics and the Future of Global Disarmament*, p. 64.
[56] Shyam Bhatia, *India's Nuclear Bomb*, p. 109.

how cheap nuclear weapons were. On 24 October 1964, for example, in a broadcast on the state-run All India Radio (AIR), Bhabha quoted a paper published by the Lawrence Radiation Laboratory, Livermore, USA, to assert that a 10 kiloton (kT) bomb would cost only U.S. $ 350,000 or Rs. 17.5 lakhs. And on the basis of these figures he claimed that "a stockpile of fifty atomic bombs would cost under Rs. 10 crores and a stockpile of fifty two-megaton hydrogen bombs something of the order of Rs. 15 crores" and argued that this was "small compared with the military budgets of many countries."[57] The 'bomb lobby' repeatedly used this speech to claim that nuclear weapons could be produced quite easily and at a relatively low cost even by a poor country like India.[58]

Second was the technical claim about DAE's ability to build nuclear weapons. Speaking in London on 4 October 1964, nearly two weeks *before* the first Chinese test, Bhabha declared that India could explode an atom bomb within eighteen months of a decision to do so.[59] And, in an attempt to provoke Prime Minister Lal Bahadur Shastri, he went on to add, "But I do not think such a decision will be taken." Seemingly in response to this, Shastri, who was attending a conference of non-aligned nations in Cairo at that time, declared that India's nuclear establishment was "under firm orders not to make a single experiment, not to perfect a single device which is not needed for peaceful uses of nuclear energy."[60]

The last caveat was the basis of the third element of Bhabha's campaign – advocating work towards building Peaceful Nuclear Explosives (PNE). Indeed, in his

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[57] Broadcast by H. J. Bhabha over All India Radio on United Nations Day, 24 October 1964, reprinted in J. P. Jain, *Nuclear India*, pp. 158-161.
[58] Shyam Bhatia, *India's Nuclear Bomb*, pp. 113-14.
[59] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 65.

crucial Lok Sabha speech on November 27, 1964 that sanctioned work towards a PNE, Shastri revealed that: "Dr. Bhabha has made it quite clear to me that as far as we can progress and improve upon nuclear devices, we should do so, as far as development is possible, we should resort to it so that we can reap its peaceful benefits and we can use it for the development of our nation." What is also significant is that Shastri had met with Bhabha just before the Lok Sabha session.[61] Clearly, Bhabha played a crucial role in obtaining political support for the PNE program.

Earlier the same year, speaking at a Pugwash conference in Udaipur, Bhabha gave a description of a deterrent relationship between two countries, even if one is much more powerful than the other. As though offering an example, Bhabha focussed on China: "[A] country with a huge population, such as China, must always present a threat to its smaller neighbours, a threat they can only meet either by collective security or by recourse to nuclear weapons to redress the imbalance in size." Though he did not mention India by name, it is clear what he thought were the options available to India. Following from this, Bhabha suggested that the only possible collective security measure would be a guarantee from both the United States and the Soviet Union.[62] The astute Bhabha could not but have recognized that neither country was likely to offer such assurances. Relations between the U.S. and India were often tense and Russia had not extended a nuclear umbrella to any country outside of the Warsaw pact. Given the only two options that he had laid out, it was easy to figure out what he was recommending for India's nuclear

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[60] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 65.
[61] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, pp. 82-83.
[62] Homi Bhabha, "Safeguards and the Dissemination of Military Power," Paper Presented by H. J. Bhabha to the 12th Pugwash Conference on Science and World Affairs, 27 January – 1 February 1964; reproduced in J. P. Jain, *Nuclear India*, pp. 139-145.

policy. In the audience were Vikram Sarabhai, who was soon to succeed Bhabha as the head of the atomic programme, Prime-Minister-to-be Indira Gandhi, and V. C. Trivedi, who was to go on to be the principal negotiator at the Nuclear Non-Proliferation Treaty (NPT) talks.

The momentum set off by Bhabha's pronouncements continued even after his sudden demise in a plane crash in 1966. Sarabhai, who took over after Bhabha, differed somewhat on the question of nuclear weapons. As George Perkovich puts it: "Sarabhai questioned the morality and utility of nuclear weapons for India and would soon take steps to reverse the peaceful nuclear explosives project."[63] While the attempted reversals are a matter of record, Sarabhai's intentions may not have derived entirely from morality. Nor did he completely reject the idea of nuclear weapons for India. What he did not endorse was the particular PNE programme envisioned by Bhabha and other senior DAE scientists. As Sarabhai himself was to declare, "Let our emphasis be on reality and not on show. I am opposed to gimmicks."[64] This view was at variance with the importance given to "performative gestures" by Bhabha, Nehru, and especially the present ruling party, the BJP. For Sarabhai, then, developing the bomb carried no symbolic meaning; instead he evaluated it in concrete, military and economic terms.

In Itty Abraham's reading, "Sarabhai was arguing, first, that India could not afford an atomic deterrent in order to be secure from external threats, as nothing short of a full-fledged atomic weapons arsenal with all its concomitant systems (deliver systems, second strike capability, command and control infrastructure) would provide that

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[63] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 114.

security. Second, and more subversively, he suggests that perhaps the more serious threat to national security came from within the country – and atomic weapons were certainly not going to be of help there."[65]

Despite Sarabhai's attempts to shift the focus of India's nuclear policy, the PNE effort continued. As Raja Ramanna, one of the leaders of the 1974 test, acknowledged in a private interview, "Sarabhai could not keep scientists from doing their work. He couldn't look over our shoulders."[66] In other words, the normal autonomy accorded to scientists in their research helped the bomb makers.[67] Design work on the nuclear explosive tested at Pokharan began in 1968.[68] Under the leadership of R. Chidambaram and Ramanna, and in cooperation with B. D. Nag Chaudhuri, scientific adviser to the Minister of Defence and Director of the Defence Research and Development Organization (DRDO), about fifty to seventy-five scientists from DAE and DRDO were directly involved in the project.

On May 18, 1974, at the height of a nation-wide railway strike (led by George Fernandes, who was then a trade union leader and is now the Defence Minister), India conducted its first nuclear test at Pokharan in the desert in Rajasthan.[69] In domestic circles, enthusiastic reception followed the tests. The scientists were feted repeatedly.

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[64] K. D. Kapur, *Nuclear Non-Proliferation Diplomacy: Nuclear Power Programmes in the Third World* (New Delhi: Lancers, 1993), p. 309.
[65] Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*, p. 144.
[66] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 123.
[67] While this may seem at odds with the lack of control over their work in the case of junior personnel, it must be remembered that Ramanna was, by then, fairly high up in the DAE.
[68] R. Chidambaram and C. Ganguly, "Plutonium and Thorium in the Indian Nuclear Programme," *Current Science* 70, no. 1 (10 January 1996), pp. 21-35.
[69] R. Chidambaram and Raja Ramanna, "Some Studies on India's Peaceful Nuclear Explosion Experiment," *Peaceful Nuclear Explosions IV: Proceedings of a Technical Committee on the Peaceful Uses of Nuclear Energy organised by the International Atomic Energy Agency*, January 20-24, 1975, pp. 421-436.

Popular magazines like the *Illustrated Weekly of India* and *Science Today* carried glowing reports on the scientists – Sethna, Ramanna, and Iyengar in particular – who made it happen.[70]

The role of the Atomic Energy establishment in pushing for the 1974 test was considerable. Apart from Bhabha, senior scientists like Homi Sethna, Raja Ramanna, P. K. Iyengar and R. Chidambaram – all of whom went on to head India's Atomic Energy Commission – played important roles in building up momentum to test. As summarized by Perkovich, "Whatever Mrs. [Indira] Gandhi's calculus [in conducting the test], the fact remained that conducting the PNE was not her idea. She disposed what others proposed: it was Ramanna, Sethna, Iyengar, Chidambaram, and, before them, Bhabha who made the PNE possible."[71] To these leaders, observes Itty Abraham, the 1974 test was "a symbol of the changing fortunes of the atomic energy establishment."[72]

Soon after the 1974 test, scientists began lobbying for further nuclear tests involving more sophisticated designs. From statements after the 1998 tests, it seems likely that P. K. Iyengar and R. Chidambaram had developed a boosted fission design that they wanted to test in early 1983.[73] Scientists were also interested in making a hydrogen bomb. Conceptual work on this probably began in the late 1970s but may not have been pursued vigorously. In a private interview to W.P.S. Sidhu, Ramanna admitted that when he got back from Jodhpur after the 1974 test, he met Mrs Indira Gandhi and told her "[m]adam now we'll have to work on the hydrogen bomb [H-bomb]. She said, 'I

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[70] Khushwant Singh, "Explosions in the Desert: Meet the Scientists," *The Illustrated Weekly of India*, 14 July 1974; "Where do we go from Pokharan?," *Science Today*, June 1974.
[71] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 176.
[72] Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*, p. 149.

knew that pressure was coming but not that fast.' So, that settled it".[74] What is more certain is that ever since the 1974 test, DAE and DRDO scientists were working quietly to produce more reliable neutron initiators, enhance the simultaneity of high explosive charges, miniaturizing a device and improve its yield-to-weight ratio. Work on the latter two areas demonstrates, even to those who believed that a meaningful distinction can be made between a "Peaceful Nuclear Explosion" and a nuclear weapons test, that the purpose of the Department of Atomic Energy was not only the exploitation of "atomic energy for… peaceful purposes."[75]

Sometime in late 1982 or early 1983 Raja Ramanna and V. S. Arunachalam, director of the Defence Research and Development Organization, made their case for a nuclear test to Mrs. Gandhi. Without portraying the test as the beginning of a nuclear weapons programme, Ramanna and Arunachalam focused on the technical arguments for testing new designs. At the end of the meeting, Mrs. Gandhi tentatively agreed for a nuclear test, only to change her mind within 24 hours.[76] One of the causes for the change is said to have been a conversation with M. K. Rasgotra, India's foreign secretary, who was reportedly confronted by an American official with satellite evidence displaying preparations going on at the test site. The conversation seems to have convinced Mrs.

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[73] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, p. 242.
[74] W. P. S. Sidhu, "The Development of an Indian Nuclear Doctrine since 1980."
[75] The 1962 Atomic Energy Act claims to provide for the development, control and use of atomic energy for the welfare of the people of India and for other peaceful purposes and for matters connected therewith. See http://www.dae.gov.in/rules/aeact.htm.
[76] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, pp. 242-243.

Gandhi that the US reaction would be strong and it would impact on the economic troubles India was experiencing then.[77]

Instead it is reported that Mrs. Gandhi wanted to test at "the appropriate moment" and in the meanwhile she wanted to "develop other things and keep them ready," as well as to "make further improvements in… [weapons] designs."[78] The "other things" that Mrs. Gandhi had in mind were long range ballistic missiles to be developed under the aegis of the DRDO. Set up in 1958 as a department of the Ministry of Defence, DRDO is the primary source of Indian military research and development.[79] As early as 1962, under *Project Indigo,* an Indo-Swiss agreement was signed to design and manufacture a Surface-to-Air missile (SAM). But with the purchase of SA-2 SAMs from the Soviet Union, the project was canceled.[80] It was in February 1972 that the DRDO embarked on its first missile development undertaking, *Project Devil*, which aimed at reverse engineering the SA-2 missile. The project was managed by Air Commodore V. S. Narayanan, who went on to become the director of the Defence Research and Development Laboratory (DRDL).[81] The project reportedly had a budget of about US $700 millions and employed between 700 and 800 technical personnel.[82] By 1974, two liquid propulsion rocket motors had reportedly been developed. However, after the failure of several prototypes, the project was canceled in 1978. Though it failed to create

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[77] Raj Chengappa, *Weapons of Peace: The Secret Story of India's Quest to be a Nuclear Power*, (New Delhi: Harper Collins, 2000), pp. 255- 261.
[78] Raj Chengappa, *Weapons of Peace: The Secret Story of India's Quest to be a Nuclear Power*, p. 260.
[79] Timothy V. McCarthy, "India: Emerging Missile Power," in *The International Missile Bazaar*, ed. William C. Potter and Harlan W. Jencks (Boulder: Westview Press, 1994), pp. 201-233.
[80] For details about the orders and deliveries see Steven J. Zaloga, *Soviet Air Defence Missiles* (Alexandria, USA: Jane's Information Group, 1989).
[81] A P J Abdul Kalam with Arun Tiwari, *Wings of Fire: An Autobiography*, p. 73.

a complete system, the Devil project led to the development of several critical technologies and components that formed the basis of the Prithvi and Agni missiles.

In 1983, shortly after the aborted nuclear test, the Integrated Guided Missile Development Programme (IGMDP) was set up. From the beginning the programme had high bureaucratic priority and many standard procurement and funding procedures were overridden.[83] The programme started with the development of five missile systems – the short range Prithvi (Earth), the intermediate range Agni (Fire), the surface to air missiles Akash (Sky) and Trishul (Trident), and the guided anti-tank Nag (Snake). By 1988, the results of the new programme were visible with the first test of Prithvi on 25 February.[84] This was followed the next year with a test of Agni. Other missile systems are also reportedly under development such as the Pinaka, the Sagarika and the Astra.

Unlike earlier efforts to develop missiles, the missile programme borrowed expertise and personnel from the Department of Space, most prominently in the form of Abdul Kalam, who was chosen to head IGMDP. Kalam had earlier led the Space Launch Vehicle Programme and thus was intimate with the details of solid propellant technology that was used for the first stage of the Agni missile. Kalam's greater contribution, however, may have been the way he chose to run the project. In a break with earlier "autistic" practices, the IGMDP involved not only the defence laboratories, but also technical institutions, universities, ordnance factories belonging to the Ministry of

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[82] S. M. Flank, 'Reconstructing Rockets: The Politics of Developing Military Technology in Brazil, India and Israel', unpublished Ph.D. dissertation, Massachusetts Institute of Technology, 1993.
[83] Anand Parthasarathy, "A Firm Purpose," *Frontline*, 10-23 June 1989, pp. 9-14.
[84] Timothy V. McCarthy, "India: Emerging Missile Power."

Defence, and public and private sector firms.[85] Following the nuclear tests of May 1998, this network has been feted. In January 1999, on the eve of Republic Day, a government press release proudly proclaimed that, "DRDO laboratories with a partner network of R&D organizations, academic institutions and industries, have been and are progressing high technology systems, against all possible difficulties. Today the nation is proud of DRDO…"[86]

The missile efforts and the development of more advanced designs were continued by Rajiv Gandhi when he took over the leadership of the country. Rajiv Gandhi brought in two contrasting tendencies into policy making. The first was an unprecedented expansion of military spending and defence modernization.[87] The second was a youthful ardour in pursuing nuclear disarmament. The latter resulted in the proposals like the plan for a world free of nuclear weapons that Rajiv Gandhi presented to the Special Session on Disarmament of the United Nations General Assembly in June 1988.[88] But, at the same time, Rajiv Gandhi also formed a small group, including scientists like Raja Ramanna, R. Chidambaram and Abdul Kalam, to "sketch India's nuclear weapon requirements and the anticipated costs required to meet them."[89] The task

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[85] "A Man and his Mission: Interview with A.P.J. Abdul Kalam," *Frontline* 25 September 1998, pp. 88-90; Timothy V. McCarthy, "India: Emerging Missile Power," p. 204; A recent example of this practice was the Memorandum of Understanding that DRDO signed with Bharathiar University to collaborate on, *inter alia*, "plasma engineering and special coatings," which are clearly topics related to problems faced when missiles reenter the atmosphere from space. "DRDO Signs MOU with Bharathiar University," *Current Science* 74, no. 9 (10 May 1998), p. 723.

[86] "DRDO Institutes Ten New Award Schemes: Awards for 1998 Announced," *Current Science* 76, no. 6 (25 March 1999), p. 719.

[87] Between 1983 and 1987, the Indian defence budget increased by 50%. Neeraj Kaushal, *India's Defense Budget: Can It be Reduced?* ACDIS Occasional Paper, University of Illinois at Urbana Champaign, p. 4.

[88] Rajiv Gandhi, "A World Free of Nuclear Weapons," Speech at the United Nations General Assembly, 9 June 1988; reproduced in *India and Disarmament: An Anthology* (New Delhi: Ministry of External Affairs, Government of India, 1988), pp.280-294.

[89] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, pp. 273-274.

force concluded that India could have a nuclear force that would "include the Agni and Prithvi missiles, aircraft and an appropriate number of warheads in low three digit figures."[90]

According to K. Subrahmanyam, shortly after putting forward his plan for nuclear disarmament at the United Nations in 1988 and being disappointed with the lack of positive response, Rajiv Gandhi gave the go-ahead to the DRDO under Arunachalam and the BARC under P. K. Iyengar to proceed with the Indian nuclear weapons program. Soon after that V. P. Singh, the new Indian Prime Minister, named Raja Ramanna minister of state for defence, signaling, perhaps, that the government was interested in pursuing the nuclear weapons program. This was strengthened with the appointment of P. K. Iyengar, who had been an important member of the team involved in the 1974 Pokharan test, as chairman of the Atomic Energy Commission in 1990. The first "Indian nuclear deterrent" – the ability to quickly assemble nuclear weapons that could be delivered by air – is said to have come into existence around this time.[91] Nevertheless, even well into the 1990s, prominent scientists such as R. Chidambaram claimed that India had not "stockpiled" or "deployed" nuclear weapons.[92]

Retired scientists, however, were more forthright, perhaps in an attempt to further the nuclear weapons effort. Thus, for example, in his 1991 autobiography, Raja Ramanna, in contrast to official claims that the 1974 test was a peaceful nuclear explosion, described how he had "been involved in the development of a *prototype*

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[90] K. Subrahmanyam, "India's Nuclear Policy – 1964-98 (A Personal Recollection)," in *Nuclear India*, ed. Jasjit Singh (New Delhi: Knowledge World in association with Institute for Defence Studies and Analyses, 1998), pp. 26-53.
[91] K. Subrahmanyam, "India's Nuclear Policy – 1964-98," p. 44.

weapon"[93] (emphasis added). P. K. Iyengar, in his 1993 retirement speech, raised the profile of the programme by claiming that "to have been able to put together an atomic device in 1974 was the most exhilarating experience of my career."[94] M. R. Srinivasan advised the Indian government to become more "hawkish" on the nuclear issue.[95]

In 1994, official scientists like AEC chairman Chidambaram and DRDO chief Abdul Kalam started a media campaign to counter American non-proliferation initiatives. Breaking a long-standing rule of the establishment, Chidambaram, in an interview to *India Today*, boasted about "how good our bomb was" when asked about the 1974 test.[96] Former AEC chairman M. R. Srinivasan declared in an interview in the *Indian Express* that "[t]here are responsible persons who know we have the nuclear weapons capability," and suggested that "We should have followed the Chinese example of open defiance and cultivation of force."[97]

Other media hawks, fed with material by scientists, added to the pressure for full-scale tests. By August 1995, the test site at Pokharan was being prepared for nuclear tests. According to former top-level scientists and policy advisers, "the strategic enclave did not need explicit political authorization to maintain the site or make other test preparation."[98] According to interviews conducted by Perkovich, the scientists justified their pressure for further tests on three grounds: "they needed to perfect and demonstrate

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[92] See for example Steve Coll, "India Faces Nuclear Watershed," *Washington Post*, 7 March 1992.
[93] Raja Ramanna, *Years of Pilgrimage*, p. 100.
[94] P. K. Iyengar, "Forty Years with Atomic Energy," farewell address, 4 February 1993, in *Collected Scientific Papers of Dr. P. K. Iyengar*, vol. 5 (Bombay: Bhabha Atomic Research Centre, Library and Information Services Division, 1993), p. 85.
[95] Rahul Bedi, "India should own up to Atom Bomb," *The Daily Telegraph*, 20 September 1994.
[96] "Say No to Regional Capping," Interview by Raj Chengappa, *India Today*, 30 April 1994, p. 46.
[97] *Indian Express*, 19 September 1994, reproduced in *FBIS-NESA*, 23 September 1994.
[98] George Perkovich, India's Nuclear Bomb: The Impact on Global Proliferation, p. 365.

their technological innovations; they believed that only full-scale explosive tests could validate their work, and therefore the nuclear deterrent; they needed explosive tests to both recruit and retain talented scientists and engineers in the nuclear and defence programs when higher paying jobs awaited them in the commercial sector." However, the planned test was called off.

Shortly thereafter the Bharatiya Janata Party (BJP) came to power in May 1996 on a hawkish platform. Scientists sought to seize the opportunity afforded by the BJP's nuclear hawkishness as soon as possible and increased preparations even before the BJP formed the government. Once again the tests were cancelled, this time because the BJP lost the vote of confidence in the parliament.

The debate over the Comprehensive Test Ban Treaty (CTBT) in 1996 was a crucial turning point in Indian nuclear policy. Even as late as March 1996, the Indian Foreign Secretary, Salman Hyder said, "We do not believe that the acquisition of nuclear weapons is essential for our national security and we have followed a conscious decision in this regard." This was completely in line with the traditional Indian view on not relying on nuclear weapons for its security. But, on 20 June 1996, when Arundhati Ghose, then the Indian Ambassador to the Conference on Disarmament, rejected the CTBT in the present form, she said that the CTBT was not "in India's national security interest" and "our national security considerations (have) become a key factor in our decision-making."

Scientists, who realized that signing the CTBT would enormously hamper their nuclear weapons efforts, lobbied behind the scenes and publicly adopted the position that the CTBT should be linked with "a time-bound programme for total elimination of all

nuclear weapons."[99] Opposing the CTBT represented a public relations opportunity for the nuclear establishment to counter publicly aired doubts about the functioning of the nuclear establishment and to provide its personnel with continued incentives for furthering nuclear weapons work.[100]

Having succeeded in getting India to vote against the CTBT, the nuclear establishment approached the Indian Prime Minister H. D. Deve Gowda for permission to conduct tests. In his own words, Deve Gowda declined "not because of the adverse reaction from the international community but because of my concern for improving the economic situation of the country."[101]

With the BJP coming back to power in 1998, scientists busied themselves with preparing for the expected tests. Even before the election results came out, while talking to a journalist about nuclear tests, R. Chidambaram came as close to publicly advocating nuclear weapon tests as any serving AEC chairman had.[102] First Chidambaram claimed that "we are prepared…, but it is [for] the policy makers to decide whether to go nuclear or keep the options open." Then when asked about the possibility of using computer simulations to develop nuclear weapons, Chidambaram responded, "[T]hen what was the use of some countries going for 2,000 explosions?" And further added, "[the] higher the database, [the] better the simulations."[103]

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[99] "Budget Doubled, Target Elusive: Interview with R. Chidambaram," *Frontline*, 26 January 1996.
[100] Dinshaw Mistry, *India and the Comprehensive Test Ban Treaty* ACDIS Research Report, University of Illinois at Urbana-Champaign, September 1998, p. 30.
[101] Parvathi Menon, "A Former Prime Minister Speaks Out," *Frontline*, 20 June 1998.
[102] George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Berkeley: University of California Press, 1999), p. 407
[103] "AEC Chief Says India Ready 'To Go Nuclear'" *Deccan Herald*, 4 March 1998, reproduced in *FBIS-NES*, 98-063.

With the tests of May 11 and 13, 1998, India's nuclear weapon scientists finally achieved "their dreams." Speaking at a joint DAE-DRDO press conference, Abdul Kalam proclaimed that "weaponization is now complete." There have also been statements that the tests have "significantly enhanced our capability in computer simulations of new designs and taken us to the stage of sub-critical experiments in the future, if considered necessary." Regardless of the accuracy of these claims, the implicit reference to the example of the Stockpile Stewardship Programme in the United States suggests that the leaders of the Indian nuclear programme now think of it as being similar to those of Los Alamos and Lawrence Livermore.

Soon after the May 1998 tests, the Indian Prime Minister Atal Behari Vajpayee publicly celebrated the role of the scientists who designed the weapons and conducted the explosions, raising science to the level hitherto reserved for those who protect the nation and feed its citizens. Though left unsaid, as must be obvious from the context, it is the kind of science practiced by the strategic enclave that he sought to place on a pedestal. Shortly thereafter, this felicitation also translated to massive budget increases for these establishments as well as several national awards to these scientists.

The nuclear and missile establishments have used their current influence and increased funding to further weapons programmes. Research on nuclear weapons with the aim of qualitative improvements and development of new designs continues. One weapon system that seems to be receiving a lot of attention is the neutron bomb; according to R. Chidambaram, India can make one.[104] Following this claim, P. K. Iyengar called for

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[104] "India can make neutron bomb: Chidambaram," *The Hindu,* 17 August 1999.

testing one.[105] Abdul Kalam, drawing on the infamous Star Wars programme of the United States, proposed building a missile shield around New Delhi.[106] Another "futuristic" weapon being pursued is a "beam weapon" that uses bursts of microwaves.[107]

Hand in hand with these qualitative developments, the nuclear establishment has also pushed for the increase in quantity of nuclear weapons material. Accordingly, in December 1999, India's Minister of State for Atomic Energy announced plans to construct a new plutonium production reactor comparable to its 100 MW Dhruva plant.[108] All these suggest that the pressure from the nuclear and missile establishments will contribute greatly to an arms race in South Asia, with disastrous consequences to the inhabitants of the region.

Opposition

Alongside this history of canvassing for, propelling and building the bomb and the associated means of delivery must also be mentioned the role of the, unfortunately few, scientists in resisting these efforts.

Despite the Nehruvian commitment to big science, the contours and institutional focus of the nuclear establishment was by no means pre-determined. Much before Bhabha became a force to reckon with in Indian science policy, the scientist who dominated discussions and formulations of science policy was the prominent physicist and astrophysicist Meghnad Saha. As early as 1938, the then-president of the Indian

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[105] "India must test n-bomb before signing CTBT," *The Hindu*, 2 May 2000.
[106] "India to Design ABM on US lines: Kalam," *The Times of India*, 5 January 2000.
[107] "Beam Weapon in Final Stages," *The Hindu*, 19 August 1999.
[108] "Questions in Lok Sabha: Govt proposes to build another nuclear reactor," *The Hindustan Times*, 16 December 1999.

National Congress, Subash Chandra Bose, had invited Saha to join the National Planning Committee. Saha became the Chairman of the Power and Fuel Sub-committee as well as a member of the River Transport and Irrigation Subcommittees.[109] Prior to that Saha had started the influential science and science policy journal, *Science and Culture* and used it to espouse his views on science planning. Saha's notions about the role of science in society were quite different from Bhabha's. Saha "emphasized 'judicious and equitable distribution' and advocated participatory democracy even in engineering projects that involve highly technical information" and his nationalism was "based on the rights and aspirations of the majority with little affiliation or identification with the Indian 'aristocratic classes'."[110] Despite the deep political roots in the Indian nationalist movement that Saha and his group had, the more elitist group led by Bhabha prevailed over the more open and democratically disposed group led by Saha.[111]

Though ousted from power, Saha continued to argue for open and university based research in nuclear physics. He opposed the AEC because it had "enveloped itself in a cloud of secrecy." In a memorandum to Nehru, Saha suggested that "the true facts of atomic energy and its implications should be placed before the country; discussion and expert knowledge and view points of different groups will enable a policy to be shaped." But all that was of no avail; Indian nuclear policy continued to be fashioned by a small coterie of decision-makers and scientists.

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[109] Robert Anderson, *Building Scientific Institutions in India: Bhabha and Saha* (Montreal: Center for Developing Area Studies, 1975), pp. 26-28.
[110] Abha Sur, "Egalitarianism in a World of Difference: Identity and Ideology in the Science of Meghnad Saha," (Forthcoming).
[111] T. V. Satyamurthy, "India's Post-Colonial Nuclear Estate," in *No Clear Reason: Nuclear Power Politics*, edited by the Radical Science Collective (London: Free Association Books, 1984), pp. 110-111.

Saha was not alone among the ranks of well-known scientists who opposed Bhabha and the AEC. Throughout the same period, the well-known physicist C. V. Raman, was very critical of nuclear weapons and of the militarization of science.[112] D. D. Kosambi, a prominent mathematician, also made an unsuccessful attempt at trying to maintain an open and participatory system and questioned high expenditures on atomic energy research and development. Unlike Saha and Raman, however, Kosambi did not head his own institution; in 1962 he was removed from his position as senior fellow at the Tata Institute of Fundamental Research.[113]

Though without much success, opposition to the activities of the DAE has continued. In the 1980s, Amulya Reddy, a physical chemist who turned his attention to energy and rural development issues, assessed the costs of nuclear power in India and discovered several problems with the way the AEC was calculating the costs. In contrast to the claims of the AEC, Reddy concluded that other options like coal and hydroelectric power were cheaper than nuclear power under realistic, rather than optimistic, assumptions.[114] More recently, he has been one of the important figures in opposing the 1998 nuclear tests. (See Amulya Reddy's chapter in this volume.)

A completely different kind of engagement is demonstrated by members of the people's science movement and scientist-activists like Surendra and Sanghamitra

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[112] M. V. N. Murthy, Madan Rao, R. Shankar, J. Samuel and A. Sitaram, "Voices against the Militarization of Science," *Current Science* 75, no. 11 (10 December 1998), pp. 1110-1111.
[113] Dhirendra Sharma, "India's Lopsided Science," *Bulletin of the Atomic Scientists*, May 1991, pp. 32-36.
[114] Amulya Kumar N. Reddy, "Nuclear Power: Is it Necessary or Economical?," *Seminar*, June 1990, pp. 18-26.

Gadekar.[115] Surendra, a physicist by training, and Sanghamitra, a physician by training, have been bringing out *Anumukti,* South Asia's only anti-nuclear magazine. Apart from attacking different aspects of Indian nuclear policy, they have carried out detailed health surveys of people living near nuclear facilities. (See chapter by M. V. Ramana and Surendra Gadekar in this volume.)

With the Indian nuclear tests of May 1998, opposition to nuclear weapons, and to a lesser extent nuclear energy, has become much more prevalent, both among society at large and among many scientists. At least two groups of scientists launched petitions signed by hundreds of individuals condemning the action by the government; as a result, there is now an organization called Indian Scientists Against Nuclear Weapons.[116] Prominent among these scientists is T. Jayaraman, a faculty member at the Institute of Mathematical Sciences (IMSc). He has gone on to becoming one of the vocal critics of the BJP government's nuclear weapons efforts. Through his articles in Indian magazines and journals like *Frontline* and *Seminar,* he has raised difficult questions about the capabilities of the Indian nuclear establishment, the draft nuclear doctrine, the efficacy of deterrence and so on.

The May 1998 nuclear tests drew flak from even within the nuclear establishment. Dr. N. Srinivasan, a former member of the Atomic Energy Commission and the first director of the Reactor Research Centre (now the Indira Gandhi Centre for Atomic Research) rued the impact of the 1998 tests on the nuclear power programme: "I have a sad feeling that the first nail was driven in the coffin of the nuclear power programme in

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[115] On people's science movements, see Vinod Raina, "Promoting People's Science," *Seminar,* May 1999, pp. 39-43.

May, ’74 and the last nails have now been hammered in, in May ’98. I fervently hope I am wrong.”[117]

Despite this relatively long history of opposition, anti-nuclear scientists in India have, for the most part, not made much use of their technical expertise. This has both good and bad consequences. In the West the peace and anti-nuclear movement was, in the words of Eqbal Ahmad, “…nuko-centric, phobo-centric (creating fear rather than understanding), techno-centric (concerned with the technology rather than causes)…”[118] This happened in part because of the privileging of the expertise of scientists. In India, on the other hand, scientists involved in anti-nuclear activities have, for the most part, come with significantly different political biographies. They are, therefore, more likely to pay heed to a vaster range of social problems, of which nuclear weapons are only one symptom, and not focus completely on technical issues.[119]

At the same time, there are, after all, technical issues related to nuclear weapons that have to be addressed through technical means.[120] Thus, there is a relative lack of independent technical expertise that could challenge statements and claims made by official scientists about various aspects of the nuclear weapons, and energy, programmes – for example, the technical feasibility, the economic viability, the safety of reactors, or the environmental impacts of the nuclear programme. This would be very valuable. As Joel Primack and Frank von Hippel argued in their 1974 book *Advice and Dissent*, “[The]

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[116] http://www.freespeech.org/isanw/
[117] N. Srinivasan, “Nuclear Tests and our Power Programme,” *Voices Against Nuclear Weapons* (Chennai: Indian Scientists Against Nuclear Weapons/Tamil Nadu Science Forum, August 1998), p. 10.
[118] Quoted in Beena Sarwar, “Peace Workshop Stresses Need for New Strategies,” Inter Press Service Report; available on the internet at http://no_nukes_sa.tripod.com/beena_workshop.html.

way in which technical experts make their services available to society can significantly affect the distribution of political power."[121]

Historically there have been many differences between how scientists have responded to and affected nuclear policy in the US and India. Apart from their contributions to building the nuclear complex, scientists in India have largely played only two kinds of roles: advisors supportive of government policy, often being even more hawkish, and dissidents. There are practically no examples of scientists who, as advisors, have exerted a moderating and disarming influence on the government.[122] To a small extent Vikram Sarabhai and M. R. Srinivasan have played this role but their dual role as purveyors of the nuclear energy programme has imposed limits on their effectiveness in moderating policy. Further, as mentioned earlier, Sarabhai was not opposed to nuclear weapons *per se.* He was only opposed to symbolic acts without enough substance. Similarly, M. R. Srinivasan's concerns were only that India would "get on to a vast weaponisation programme which is harmful to the interests of the common man in this country and to the people in the region generally."[123] Nevertheless, he felt that weaponisation is "inevitable."

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[119] For an elaboration of this argument, see M. V. Ramana, "For a Just Peace – The Anti-nuclear Movement in India," *Social Science Research Council Newsletter* 12 (May 1999).
[120] H. A. Feiveson, "Thinking About Nuclear Weapons," *Dissent*, Spring 1982, pp. 183-194.
[121] Joel Primack and Frank von Hippel, *Advice and Dissent: Scientists in the Political Arena*, (New York: Basic Books, 1974), p. ix.
[122] On the role of scientist-advisors in the U.S. see Joel Primack and Frank von Hippel, *Advice and Dissent: Scientists in the Political Arena*.
[123] Sukumar Muralidharan, " 'Weaponisation is Harmful': Interview with M. R. Srinivasan," *Frontline*, June 6, 1998.

In the wake of calls by the leaders of the strategic enclave to "build up a military industrial complex",[124] it is imperative that scientists and society in general resist the pressures to turn all of science into "the handmaid of the war machine". In the United States, the combined effects of a large scale military industrial complex and what David Dickson terms "The New Politics of Science" has led to a situation wherein "planning for science is now exclusively based – whether in the short, the medium, or the long term – on the needs of the military and the marketplace; social objectives (such as the protection of health or the natural environment)… are accepted only to the extent that they are compatible with increased military strength or commercial profits."[125] However, opposition to nuclear weapons or energy must not be seen as just that. It must be viewed as part of developing alternative sources of technical expertise, grounded in local realities and reflecting the aspirations of the vast majority of people.

Conclusion

India's nuclear programme started with the promise of producing cheap electricity that was assumed to be necessary and, to a large extent, sufficient for "progress". Failing in this task, the programme, or more precisely the institutions that ran the programme, invented a different rationale to ensure continued funding. This was by entering the "national security" business, clearly a goal certain to gain support from political elites. The nuclear establishment along with the DRDO, i.e., the strategic enclave, performed this task with enthusiasm. Their contributions are not confined merely to designing and manufacturing the bomb but also includes lobbying with political leaders and mobilizing

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[124] T. Jayaraman, "Indian Science After Pokhran II," *Seminar*, August 1998, pp. 60-64.

elite constituencies, often indirectly, but also directly through public advocacy for nuclear weapons and missiles. By seeking power through their claims of knowledge and expertise, the strategic enclave, and to some extent the larger scientific community, cannot escape responsibility for the enormous impacts on the "one-sixth of humanity" that Prime Minister Vajpayee invoked to justify his decision to conduct the May 1998 nuclear tests. It is up to this one-sixth of humanity, i.e., the people of India, to hold them responsible.

Because the responsibility flows from the connection between knowledge and power, the road out of the bomb's shadow passes through the fields of power and knowledge. The challenge to the power of the elites comes from the "new" social movements and the much older labour movements, which have been attempting to bring democracy and justice as the basis of decision making.[126] Scientists, as well as other professionals, with their knowledge and expertise must join this caravan.

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[125] David Dickson, *The New Politics of Science* (Chicago: The University of Chicago Press, 1988), p. 18.
[126] On the "new" social movements, see for example Arthur Bonner, *Averting the Apocalypse: Social Movements in India Today* (Durham: Duke University Press, 1990) and Gail Omvedt, *Reinventing Revolution: New Social Movements and the Socialist Tradition in India* (Armonk: M.E.Sharpe, 1993).