Teaching The Leviathan
Secrecy Ignorance & Nuclear Proliferation

Presented to the Faculty of the Graduate School of Cornell

University in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

By

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January 2014

ABSTRACT

Teaching the Leviathan:
Secrecy, Ignorance and Nuclear Proliferation

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Cornell University 2014

When compared to other nuclear weapon powers why has India historically lagged in the
development, deployment, and operational planning of its nuclear force despite
unambiguous national security threats? My dissertation answers this question through a
cross-sectional study of three decades of Indian nuclear decision-making from 1980 until
2010. Using a multi-disciplinary approach, which combines insights from New
Institutionalism, organization theory and Cognitive Psychology with historical process
tracing and elite interviewing methods, I argue that there are two interrelated causes for the
Indian state's historic underperformance: (a) the absence of a strongly institutionalized
"epistemic community" within the state; and (b) the absence of shared policy-planning and
decision-making processes. The first cause is institutional while the second is organizational.
I show that epistemic communities as knowledge brokers are necessary for socializing a
state's decision-makers into new learning practices. For learning to occur, epistemic
communities must also operate in relatively open and non-monopolistic policy planning and
decision-making environments. The latter reduce the scope for heuristics and cognitive
biases and are conducive for relatively rational and optimal policy outcomes. I present
evidence to show that Indian decision-makers partially mobilized a national security-centric
"epistemic community" in the pre-1998 era; and only slowly institutionalized it within the
state in the post-1998 decade. These base conditions when grafted on to highly centralized,
compartmentalized and monopolistic policy planning and decision-making processes,

attenuated the Indian state's policy capacity. The net result has been policy outcomes riddled

with heuristic and cognitive biases alongside the weak actualization of instituted policies.

BIOGRAPHICAL INFORMATION

Gaurav Kampani grew up in India where he studied history. He moved to the United States in 1995 for a Masters degree in International Relations at the American University in Washington, DC. There his research interests focused on nuclear proliferation and arms control. During his time in DC, Kampani was a recipient of the Herbert Scoville Jr. Peace Fellowship and interned at the Natural Resources Defense Council and the US Institute of Peace. Upon completing his degree Kampani moved to Monterey, CA to work as a researcher at the James Martin Center for Nonproliferation Studies. His work at the Center concerned North East and South Asia and he was actively involved in developing global open-source databases on weapons of mass destruction. After nearly eight years at the Center, Kampani joined the graduate program Cornell University's Department of Government. Here he pursued his interests in international relations and comparative politics with a narrower focus on the politics of nuclear proliferation and South Asia. Kampani's interests span institutions, the sociology of large technological systems, military strategy, cognitive psychology and decision-making.

Acknowledgements

Dissertations are long in the making and mine is no different. Five years have passed from the time when I first started developing ideas that have become a part of this work. Before starting graduate school, I had a relatively benign notion of what it took to produce a work of this scale and magnitude. But after an eight-year slog, I have turned highly sensitive and appreciative of data, evidence and what it takes to construct an original argument. As my advisor Peter Katzenstein once remarked wryly: graduate students are a perpetually dissatisfied lot in the classroom except when it is time for them to produce their own work!

This dissertation is my intellectual work. Yet it is a collective endeavor involving many. I owe primary thanks to my committee members: Peter Katzenstein, Matthew Evangelista, Christopher Way and Sumit Ganguly. In a sense, Peter Katzenstein is the architect of this project as it was he who pushed me on a field trip to India to try and collect data, which I until then had thought was impossible to obtain. When external funders declined to fund my research citing precisely those data concerns, Katzenstein found money internally within Cornell, without my active knowledge of what it took for him to do so. When I despaired that my data might not add up, he reminded me aptly that research was a quest for what might exist, not what we suppose exists. Through all these years, he was unwavering in his intellectual and emotional support, answering every email I wrote him, returning chapter drafts in record time and providing feedback that was exquisite in its attention to detail. The treatment I received from him is probably no different from that received by dozens of students he has shepherded over the years. Through him I learnt the institutional significance of having a first-rate academic advisor in graduate school.

they receive. In this regard, I was particularly lucky to have help from Tina Slater, Judy Virgilio and Laurie Coon at the department. Tina is literally the department's administrative keystone. Forever smiling, accommodating and juggling the furiously competing demands on her time, she was the one who saw me through all the administrative thickets of Graduate School safely. I doubt I would be graduating in her absence. Outside the department, I owe deep gratitude to Elaine Scott. She was the constant gardener who tilled the soil of award money paperwork at the Reppy Center to ensure that my research would flower.

Above all, it was the support I received from family and friends that saw me through graduate school. My friend Scott turned out to be an angel investor in this endeavor. LeBron, my then partner, gave up his wonderful apartment downtown so that we could set up home together, sparing me the trouble of putting everything in storage before heading to India for field work. Miserable in the first few days in Delhi, my first instinct was to take the next flight back to New York. It was the daily Skype call with LeBron and his reassurance of home and continuity that helped me overcome my homesickness. In India, my mother took care of me so that I could focus on research without bothering with the logistical details of setting up house. Back in California, the place I truly consider home, my friends He Seon, Chris, Duane and Sangeeta always kept an open home so that I could get away from the grey of Ithaca, which someone described as "the place where clouds come to die." My colleague Sree and her husband Dhanu shared thousands of air miles generously to fly me several times between India and the US.

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AEC	Atomic Energy Commission
BARC	Bhabha Atomic Research Centre
CCS	Cabinet Committee on Security
CEA	*Commisariat a l'Energie Atomique*
CDS	Chief of Defence Staff
C-in-C	Commander-in-Chief
CoSC	Chiefs of Staff Committee
DAE	Department of Atomic Energy
DE	damage expectancy
DND	Draft Nuclear Doctrine
DNSA	Deputy National Security Advisor
DRDL	Defense Research & Development Laboratory
DRDO	Defense Research & Development Organization
EMIS	Electromagnetic Isotope Separation
ERL	Engineering Research Laboratories
GoM	Group of Ministers
IAEA	International Atomic Energy Agency
IAEC	Iraq Atomic Energy Commission
IAEC	Israel Atomic Energy Commission
IAF	Indian Air Force
ICBM	inter-continental ballistic missile
IDS	Integrated Defence Staff
IDSA	Institute of Defence Studies & Analyses
IGMDP	Integrated Guided Missile Development Program
ISRO	Indian Space Research Organization
JIC	Joint Intelligence Committee
LEU	low-enriched uranium
LWR	light water reactor
MIRV	Multiple Independently Targetable Re-entry Vehicle
NBC	nuclear biological & chemical
NCA	National Command Authority
NFU	no-first-use
NSA	National Security Advisor
PAEC	Pakistan Atomic Energy Commission
PAF	Pakistan Air Force
PIG	Penning Ionization Gauge
PMO	Prime Minister's Office
PNE	Peaceful Nuclear Explosion
SFC	Strategic Forces Command
SOP	standard operating procedure
TD	technology demonstrator
UF6	Uranium Hexafluoride
VCDS	Vice Chief of Defence Staff

CHAPTER ONE

THE PUZZLE OF INDIA'S LAGGING NUCLEAR PERFORMANCE

What is Odd About Indian Nuclear Behavior?

Since the late-1970s, India has exhibited a pattern of lagging national security responses to unambiguous nuclear threats. Realist theory posits that states confronting protracted power rivalries and lacking the benefits of great power nuclear protection will acquire nuclear weapons.[1] India however bucked that trend until the late1980s despite mounting threats from Pakistan's nuclearization and Sino-Pakistani nuclear collaboration. Even after India built nuclear weapons in the 1990s, it continued to show slack by not building institutional capacities necessary to wield them. Organizational theorists who maintain that India's nuclear drive is the consequence of advocacy efforts by a "strategic enclave" consisting of nuclear scientist-bureaucrats[2] have never explained the 24 year gap between its first and second round of nuclear tests; or why the scientist-bureaucrats refrained from seeking alliances with the Indian military, the surest route to a weapons program. Similarly, explanations that cite prestige as the reason for not just why India has sought nuclear weapons but also for why it minimizes their operational utility[3], must surely find it perplexing that four Indian governments kept the existence of the arsenal secret for a decade; and that successive Indian governments remain committed to investing in the organizational and technical accoutrements of a nuclear force even after India has been accorded the status of a *de facto* nuclear weapon power. The many theories for such behavior

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[1] T. V. Paul, *Power Versus Prudence: Why Nations Forgo Nuclear Weapons*, (Montreal: McGill-Queen's University Press, 2000).
[2] Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*, (New York: Zed Books, 1998).
[3] Karsten Frey, *India's Nuclear Bomb and National Security*, (New York: Routledge, 2006).

notwithstanding, Indian nuclear policy remains in Winston Churchill's famous words from another context "a riddle wrapped in a mystery inside an enigma."

From the late 1970s on, Indian decision-makers had clear evidence of Pakistan's nuclear quest.[4] Indian national security elites understood that a Pakistani nuclear arsenal would alter the balance of power in South Asia. It would sharply degrade the conventional superiority India had historically enjoyed over Pakistan since their founding.[5] Of greater concern to them was the negative shift in the "balance of threat"[6] as evidenced by Pakistan's attempts at breaking up the Indian union: first by supporting secessionist insurgents in the sensitive Indian state of Punjab[7] and later Kashmir.[8] In the winter of 1986-87 when India and Pakistan almost came to blows during a crisis triggered by India's Brasstacks military war games,[9] Pakistan communicated a nuclear threat through the Indian ambassador in

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[4] "Nuclear Backdrop," *The Kargil Review Committee Report: From Surprise to Reckoning*, (New Delhi: Sage Publications, 1999), p. 186.

[5] For example, the late Chief of Army Staff General Sundarji published a series of seminal papers on the effects of nuclear asymmetry on conventional war fighting in the early 1980s. "Effects of Nuclear Asymmetry on Conventional Deterrence," *Combat Paper No. 1*, (Mhow: College of Combat, 1981); "Nuclear Weapons in a Third World Context," *Combat Paper No. 2*, (Mhow: College of Combat, 1981).

[6] I borrow this phrase from Stephen Walt who argues that states' balancing behavior is triggered not just by a shift in the balance of power, but by their perceptions of threats inherent in that shift based on the opposing state's strength, geographical proximity, offensive capabilities and offensive intentions. Although Walt's argument concerns states' external balancing versus bandwagoning behavior, I extend his concept to 'internal balancing'. Stephen M. Walt, "Alliance Formation and the Balance of World Power," *International Security*, Vol. 9, No. 4, (1985), pp. 3-43.

[7] "Joint Intelligence Committee (JIC) Paper No. 8/94 on Anti-India Activities of the ISI on the Indian Sub-Continent," cited in "Review of Events Leading up to Kargil," in *The Kargil Review Committee Report*, p. 71.

[8] Ibid., pp. 53-78.

[9] P.R. Chari, Kanti P. Bajpai Pervaiz Iqbal Cheema, Stephen P. Cohen and Sumit Ganguly, *Brasstacks and Beyond: Perception and Management of Crisis in South Asia*, (New Delhi: Manohar, 1995), pp. 23-67.

Islamabad.[10] India's response, beginning in the early 1980s, to these adverse shifts in the balance of power and threat was an experimental and disaggregated effort to develop advanced nuclear weapon designs and ballistic missiles.[11] In the spring of 1988 top Indian policy planners and decision-makers received confirming evidence that China had passed on a nuclear weapon design tested in 1966 to Pakistan and that "Pakistan was in possession of at least three nuclear devices of 15-20 kiloton yield."[12] However, the Indian prime minister waited until the spring of 1989 before authorizing weaponization to formally commence and appointing a lead coordinator within government to oversee that effort.[13] The doyen of Indian strategists and nuclear consultant to virtually all Indian governments since the early 1980s, the late K. Subrahmanyam subsequently disclosed: "in the period between 1987-1990 India was totally vulnerable to a Pakistani nuclear threat."[14]

This late start point, behind Pakistan's weaponization efforts, had negative downstream effects for India in the decade of the 1990s. When the next Indo-Pakistani crisis blew up over Kashmir in the winter/spring of 1989-1990, India had no ready arsenal.[15] During this crisis, the Pakistani foreign minister delivered what Delhi thought was a veiled nuclear threat.[16] But the prototype weaponized device under development had until then not even

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[10] "Nuclear Backdrop," *The Kargil Review Committee Report*, p. 191.

[11] B.G. Deshmukh, "Keep the Faith," *Hindustan Times,* (September 7, 2006), http://www.freerepublic.com/focus/f-news/1698250/posts, (December 2010).

[12] "Nuclear Backdrop," *The Kargil Review Committee Report,* pp. 188, 190.

[13] Raj Chengappa, "The House Is On Fire," *Weapons of Peace: The Secret Story of India's Quest to be a Nuclear Power*, (New Delhi: HarperCollins Publishers India, 2000), pp. 332-333.

[14] K. Subrahmanyam, "Indian Nuclear Policy – 1964-98 (A personal recollection)," in Jasjit Singh ed., *Nuclear India*, (New Delhi: Knowledge World, 1998), p. 44.

[15] Chengappa, "End the Wink and Nudge Approach," *Weapons of Peace,* p. 354.

[16] *The Kargil Review Committee Report*, pp. 65, 204.

been shown to the air force.[17] Neither had the government done any nuclear contingency planning. Nuclear command and control apparently consisted of the prime minister, his principal secretary and the scientific advisor to the defense minister. Nor did there exist institutional guidelines and procedures to help political authorities cobble up a nuclear response.[18] Although many assumed that India and Pakistan were nuclear capable in the early 1990s, it is highly unlikely that India achieved the technical capability to deliver nuclear weapons safely and reliably before 1994-1995.[19] But equally germane, the state did not develop the institutional capacity to manage its nuclear hardware in any instrumentally meaningful way in the decade of the 1990s. The term institutional capacity here refers to the civil-military chain of command, use doctrine, standard operating procedures, practice drills and ground rehearsals to coordinate action among and across the various agencies tasked with responding to a nuclear emergency. It also refers to operational planning in the military's tactical meaning of the term.[20] This state of affairs continued even after India conducted nuclear tests in May 1998 and formally laid claims to nuclear power status; until the summer of 1999 when it suddenly found itself at war with Pakistan over the latter's

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[17] Shekhar Gupta, "Know What They Did That Summer," *Indian Express*, August 12, 2006, http://www.indianexpress.com/news/know-what-they-did-that-summer/10366/, (December 2010).

[18] Chengappa, "End The Wink And Nudge Approach," *Weapons of Peace,* p. 355.

[19] According to Scientific Advisor to the Defense Minister APJ Abdul Kalam's testimony before the Kargil Review Committee, weaponization was completed during 1992-94. The records of this and other conversations pertaining to India's nuclear weapons program from the early 1980s until 1998 are contained in the annexure to the report, which has not been declassified. The author's interviews with several senior retired Indian Air Force officers at the highest levels suggest that India achieved an air deliverable capability sometime in 1995. See, "Nuclear Backdrop," p. 205; senior Indian defense official 'Z', non-attributable interviews with author, December 2009 & February 2010, New Delhi, India.

[20] Senior Indian defense official 'X', non-attributable interviews with author, October & November 2009, New Delhi, India.

unprovoked occupation of the Kargil heights in Kashmir. This was the historical moment

when the Indian government initiated nuclear operational planning with the air force.[21]

Post-1998, India set out to create the institutional and ideational edifice for a "credible

minimum deterrent."[22] Indian political decision-makers are now committed to taking nuclear

capabilities beyond technological symbolism into realizable forces in the field. However, in

the past decade, the socialization of the Indian state into the operational practices of nuclear

deterrence has proceeded slowly. Three problems abound. First, serious reliability concerns

continue to dog the lethality of the Indian nuclear force, both nuclear warheads and missile

delivery systems.[23] Second, although the Indian government has institutionalized the role of

the military in nuclear force management through the creation of a Strategic Forces

Command (SFC), the latter's role within the Indian military is relatively isolated. It, the SFC,

does not control delivery systems, which remain under the separate custody of the three

conventional services (army, navy and air force).[24] The institutional quarantining of the SFC

and fragmented control of the arsenal has raised serious questions about the military's *intra-*

agency coordination practices. The absence of strong institutional coordination mechanisms

at the top within the Indian military has made this problem particularly acute. Institutional

problems afflict not only nuclear force management, but they also prevent synergization

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[21] Senior Indian defense official 'A', non-attributable interviews with author, July & August 2010, New Delhi, India.
[22] See section titled 'Objectives' in National Security Advisory Board, *India's Draft Nuclear Doctrine*, (New Delhi: Government of India, August 17, 1999).
[23] Verghese Koithara, "Nuclear Hardware," *Managing India's Nuclear Forces,* (Washington, D.C: Brookings Institution Press, 2012), pp. 123-138.
[24] Admiral (retd.) Arun Prakash, Chairman Chiefs of Staff Committee (2005-2006), interview with author, April 2009, Dehradun, India.

between the military's conventional and nuclear arms.[25] Other institutional lacunae stem from the task of *inter*-agency coordination between the military and the scientific agencies. The latter retain exclusive control over nuclear warheads, an institutional routine that stretches the logistical demands for operability.[26] These technical and institutional concerns raise serious doubts about the operational effectiveness of the Indian nuclear force.

The Research Questions and the Dissertation's Answers in Brief

How did India, a regional power with a proven nuclear capability as early as 1974, a state with greater resources, and a considerably larger and more sophisticated scientific, industrial, and nuclear establishment than Pakistan end up in a position of relative vulnerability to the latter from the late-1980s until the mid-1990s? Similarly in the decade of the 1990s, despite the history of Pakistani nuclear threats, the high regional political and military volatility, and the threat of war with Pakistan ever present due to the latter's low-intensity operations in Kashmir, why did the Indian state not create institutional capacities to instrumentally manage its fledgling nuclear force? Even odder still, why has India been so slow in resolving the technical and institutional lacunae in its current nuclear operational practices when external nonproliferation pressures no longer constrain domestic policy and regional nuclear rivalries and the threat of war with Pakistan and China remain a constant?

I answer these questions by analyzing three cases of Indian nuclear decision-making between 1980 and 2010. Using a multi-disciplinary approach, which combines theoretical insights from New Institutionalism, and cognitive psychology and organizational theory with

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[25] Air Marshal (retd.) Ajit Bhavnani, C-in-C, Strategic Forces Command (2004-2006), interview with author, April 2009, New Delhi, India.
[26] Prakash, interview with author; also see, Koithara, "Operational Level Management," *Managing India's Nuclear Forces*, pp. 169-174.

historical process tracing and elite interviewing methods, I shine the spotlight on the process of learning within the Indian state. In my definition, learning means the modification of existing knowledge or the acquisition of new knowledge and its institutionalization into a state's habitual routines. Through my research I present evidence to show that whereas the Indian state has adapted to external pressures, it has generally been weak in nuclear learning. In adaptation, systems change incrementally. They satisfice by adding new programs to old ones without holistically questioning the means and ends relationships. In learning, however, systems optimize by synergizing the means and ends relationships.

I argue that the process of learning in states is contingent upon the growth of internal information and knowledge markets, the structured processing of information and the robust management of human capital. Learning in any state will be as good as its institutional and organizational capacity to aggregate information and knowledge markets, integrate them with human capital and monitor their performance. However, learning in covertly proliferating states is problematic because it occurs under an institution of severe internal secrecy. The latter is necessary to hide the state's activities from the scrutiny of a hostile nonproliferation regime. However, secrecy is also problematic because it spawns internal opacity and compartmentalizes information. These institutional conditions cocoon decision-makers in a regime of relative ignorance. Unless decision-makers consciously apply themselves to counteract the pernicious effects of this regime of ignorance, learning and socialization practices in the state will be weak and performance lags will remain a recurring phenomenon.

At a basic level, the fundamental security challenge that states face in the international system is one of uncertainty. All states dealing with uncertainty confront three instrumental questions: What is to be accomplished? When must it be accomplished? And how should it be accomplished? To answer these questions, states typically mobilize society's curators of knowledge, its "epistemic community." Epistemic communities are knowledge brokers that enable decision-makers frame answers to these questions. Through this process of educating decision-makers, they help states learn. Hence, the institutionalization of epistemic communities within the state is a necessary precursor for socializing decision-makers into new learning practices. However, the strong institutionalization of epistemic communities alone is a necessary but insufficient condition in itself for inducing learning within a state. For the latter to happen, a second condition is necessary. The epistemic communities must operate in decision-making environments, which permit relatively open access to information and subject policy planning and decision-making processes to a "wisdom of the crowds" peer review process. The institutionalization of epistemic communities and shared policy planning and decision-making processes together constitute the base conditions for strong learning within the state. They reduce the scope for heuristics and cognitive biases in decision-making and pave the way for rational and relatively optimal policy outcomes. Finally, decision-makers should also be able to effectively monitor their epistemic and bureaucratic agents within the state. Otherwise, "information asymmetries" can produce sub-optimal outcomes often unbeknownst to decision-makers.

I present evidence to show three interrelated causes for weak state learning or what I characterize as the Indian state's lagging performance. The first is Indian decision-makers' partial mobilization of a national security-centric epistemic community prior to 1998 and it's

slow-institutionalization within the state in the post-1998 decade. These base conditions

when grafted on to highly centralized, compartmentalized and monopolistic decision-making

processes have historically attenuated the Indian state's policy capacity. Secrecy and the

compartmentalization of information also have denied political principals the means to

effectively monitor the performance of the scientific and bureaucratic agents in the state.

The net result has been policy outcomes riddled with heuristic and cognitive biases alongside

the weak actualization of instituted policies.

Understanding Lag

The term lagging performance means the latency between signals that stress threatening

changes in a target state's external environment and the state's institutional responses to

address them. Lag also implies sub-optimality. Measures of sub-optimality, however, can be

problematic depending on one's choice of framing. One method of assessing the optimality

of the Indian state's policy choices would be against some form of rational choice, formal

and informal. But there is a problem with abstract models of structured choice. Their

emphasis on utility maximization, rank ordering of preferences, transitive preference

orderings, and utility payoffs are more likely to inform the decisions of methodologically

trained social scientists than those of political leaders. Further, leaders' stated and revealed

preferences are often difficult to reconcile making the use of formal rational choice models

highly assumptive.[27]

An alternative approach would be to use informal rational choice. This means some

measurement of outcomes against understandings of what we would consider sane,

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[27] Donald P. Green & Ian Shapiro, *Pathologies of Rational Choice Theory: A Critique of Applications in Political Science* (New Haven: Yale University Press, 1994), pp. 14-17.

commonsensical and internally consistent. Reasonable as this may sound, our notions of informal rationality are also highly context and domain specific. This makes comparative measurement difficult. Due to the inherent biases in both formal and informal rational choice models, I adopt three alternative means to measure the Indian state's nuclear performance. The first measure is global. It compares the Indian state's degree of isomorphic adaptation to the nuclear practices of all the other nuclear weapon powers. The three metrics of measurement I use in this regard are timelines for: (1) nuclear device development; (2) weaponization; and (3) basic operational planning. As a second regional measure, I compare Indian and Pakistani nuclear developments along each of these metrics. The third measure is local. It compares the gap between the institution and the actualization of the Indian state's nuclear policy goals from 1980-2010.

Organizations, as Schelling observed, "respond to an environment that consists of other organizations responding to an environment."[28] Since the invention of nuclear weapons in 1945, the five legally recognized nuclear weapon states (henceforth referred to as the NPT-5), all followed a broadly similar path from the development process of the weapons to their operational deployment. The gold standard for comparison in this case would be the technical, institutional, and operational art of the NPT-5. In DiMaggio and Powell's isomorphic typology for example, organizations homogenize by responding to coercive environmental, mimetic, or normative pressures.[29] However, state nuclear responses to such pressures will typically vary depending on where their relative power and position in the international system. The responses of great powers will differ from those of regional

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[28] Paul J. DiMaggio & Walter W. Powell, "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review,* Vol. 48, No. 2 (April 1983), p. 149.
[29] Ibid.: 150.

powers. Domestic political consolidation, economic, and technological capacity also shapes

the capacity of states to adapt to external pressures. Mimicry and normative socialization in

the case of nuclear proliferation work in reverse as proliferators face negative incentives for

replicating the practices of the NPT-5.[30] But despite these problems, timelines for nuclear

device development and weaponization provide a rough measurement for comparative

performance. Categories such as 'institutional capacity' and 'operational art' are inherently

more sophisticated means and fuller measures to compare baseline performance. Credible

and unambiguous data concerning them are generally not available for most "second-tier"

nuclear weapon powers.[31] For this reason, I use the simpler metric of basic operational

planning.

A nuclear device is commonly understood as "…fission and fusion materials, together with

their arming, fuzing, firing, chemical high explosive, and effects-measuring components, that

have not yet reached the development status of an operational weapon…system designed to

produce a nuclear explosion for purposes of testing the design, for verifying nuclear theory,

or for gathering information on system performance."[32] When measuring timelines for

nuclear device development among various nuclear powers I take the start point as the year

in which the nuclear weapon power made a political decision to develop such a device for

ostensibly peaceful or military purposes. The end point of device development is not an

actual test explosion in the field but technical completion in the laboratory. Based on these

criteria, India's decade-long development period is a little below the global average of eight

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[30] Maria Rost Rublee, *Nonproliferation Norms: Why States Choose Nuclear Restraint* (Athens: University of Georgia Press, 2009), pp. 1-33.

[31] I categorize countries that developed nuclear devices and weapons after the passage of the 1968 Nuclear Nonproliferation Treaty as "second-tier" nuclear weapon powers.

[32] Chuck Hansen, *U.S. Nuclear Weapons: The Secret History*, (New York: Orion Books, 1988) p. 13.

years. But if we assume that second-tier nuclear weapon powers operate on a different "world time" then India's development timeline is equivalent to that of its peers.

Table 1

NUCLEAR DEVICE & WEAPONIZATION DEVELOPMENT TIMELINES
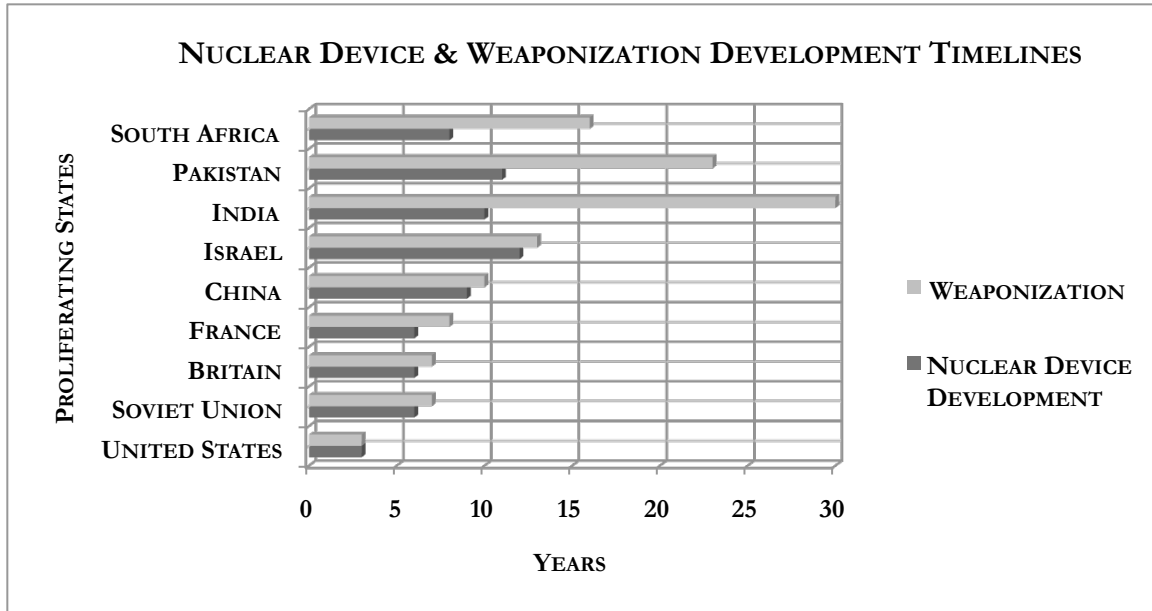
However, when we turn to weaponization, "the conversion or modification of a nuclear test device into a combat-ready warhead," which "includes the design and production of a ballistic casing (and any required retardation and impact-absorption or shock-mitigation devices) as well as special fuses, power sources, and arming and safing systems or equipment,"[33] India stands out as an outlier. On average nuclear weapon powers took 14 years to build weaponized systems. India's timeline was twice that. The transition time

[33] Ibid., p. 17.

between weapon development and weaponization for a nuclear weapon power on average was five years. India's timeline for completing weaponization was 20 years, four times that average. For the most part, nuclear powers have developed operational routines fairly quickly in the wake of weaponization. In the case of US, Britain, Israel and Pakistan there were no gaps at all. The gap was only one year for the former Soviet Union and China; and two for France. In India that gap was five years.

Table 1.1

Gap Years Between Nuclear Device Development & Weaponization
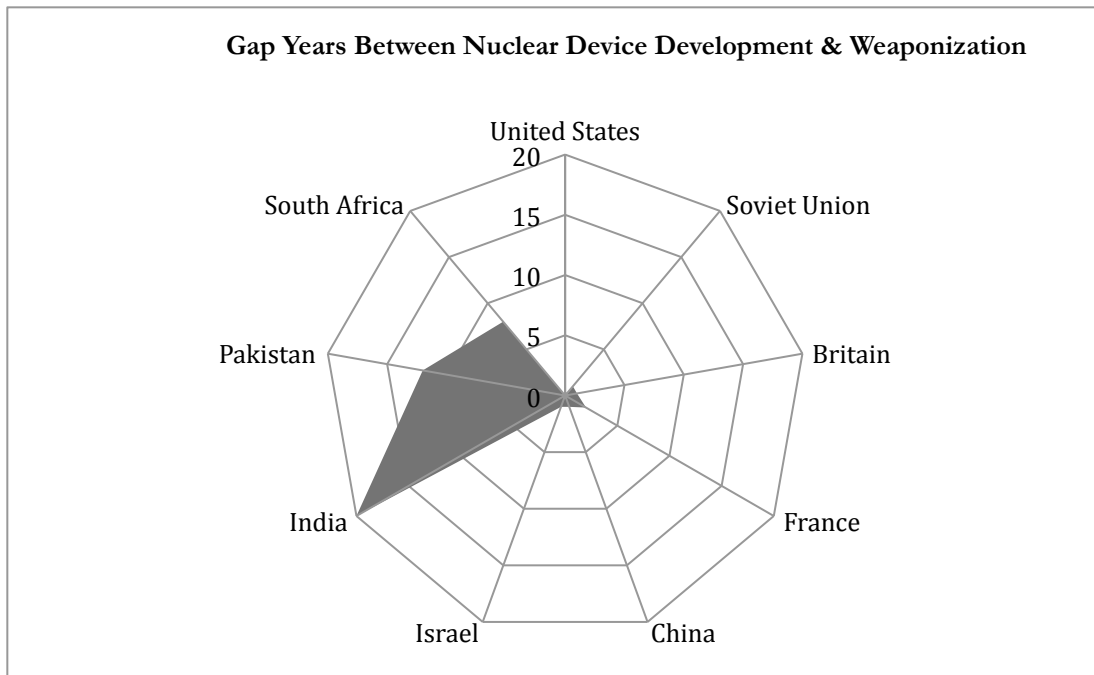
The global trends are replicated at the regional level in South Asia as well. Despite India's

decade-long head start over Pakistan in the development of nuclear devices, both countries

ended near simultaneously in developing reliable and safe air deliverable capabilities in

1995.[34] However, Pakistan followed up this technical threshold with preliminary operational

planning led by the military's Combat Directorate; and "joint exercises" between its scientific

agencies, the air force and the military command.[35] In India, basic operational readiness

languished until the summer of 1999. Further, in the aftermath of the 1998 tests and overt

claims to nuclear status, Pakistan systematically revamped it nuclear command authority and

nuclear weapons-related management practices. Between 1999 and 2001, the Pakistani

military redesigned its nuclear command and control structure, developed an operational

nuclear doctrine and completed preliminary plans to integrate nuclear weapons with

conventional war planning. Matching efforts in India only began in 2003 and did not take

institutional root until 2004-2005.

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[34] Feroz Hassan Khan, "Building the Bomb," *Eating Grass: The Making of the Pakistani Bomb*, (Stanford: Stanford University Press, 2012), pp. 186-187.
[35] Ibid.; "Establishment of Robust Command and Control," *Eating Grass*, pp. 325-328.

Table 1.2

Time Gap Between Weaponization & Basic Operational Planning
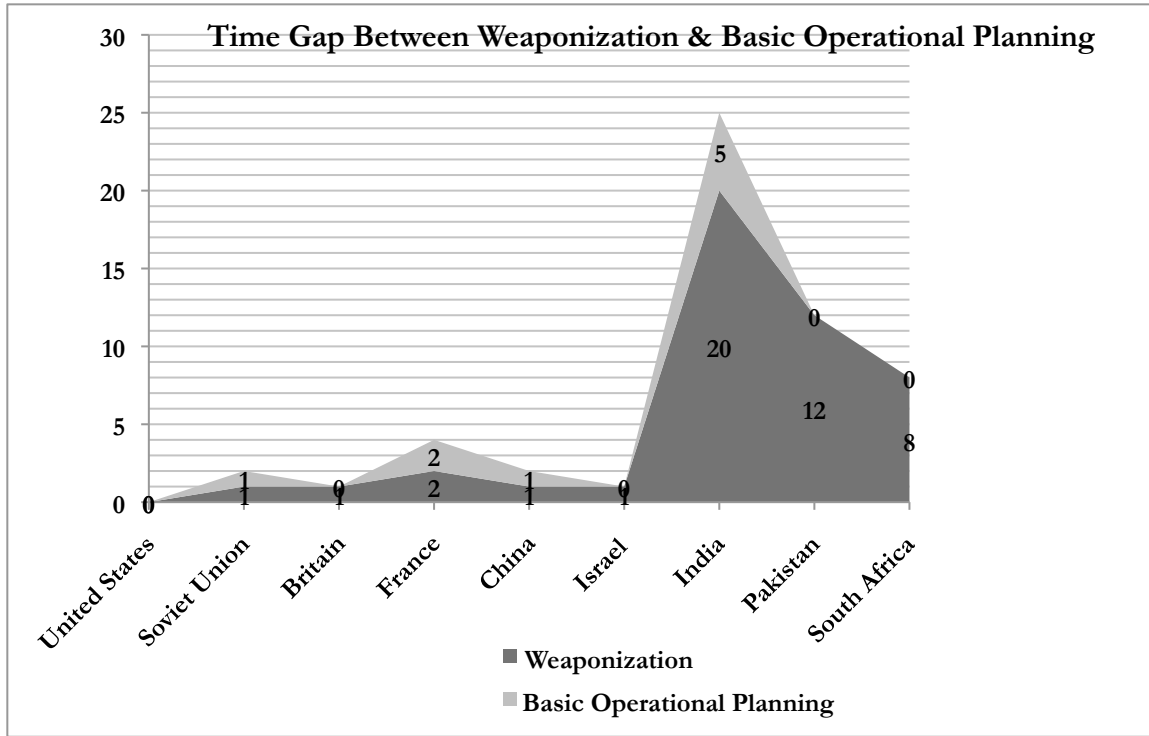
Finally, apart from global and regional trends, I also include local metrics, by which I mean the Indian state's self-identified nuclear threats and policy measures to address them, as a tertiary basis for comparison. Using open-source literature and elite interviews, I measure lag against three successive policy goals during the 1980s, the 1990s, and the post-1998 decade. During the 1980s, the Indian government's policy of keeping its nuclear option open was not simply a passive option. The goal, in Indian parlance, was to "keep everything ready" so that as then Prime Minister Rajiv Gandhi put it "…if India decided to become a nuclear power, it would take a few weeks or a few months."[36] However, the process of becoming a

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[36] Leonard S. Spector, *New Nuclear Nations,* (New York: Vintage Books, 1985), p. 95.

"nuclear power" that was expected to last a few months, took six years to accomplish. Policy evolved in the immediate aftermath of the Kashmir Crisis with Pakistan in 1990. The new goals were to develop an assured retaliatory capability and an emergency management system to enable the government respond to Pakistan-specific nuclear contingencies.[37] India achieved the narrow goal of weaponization in the sense of developing the capacity to deliver nuclear weapons safely and reliably by the mid-1990s. But the organizational-management procedures and tactical operational planning necessary to actualize technical means went unrealized. Finally, in the last decade, with overt nuclear status, the Indian state resolved to credibly wield a minimum nuclear deterrent. There has since been an expansion in the state's technical, organizational, and procedural capacities with the latter goal in mind. But lacking in this equation once again are well-developed ideational, intra- and inter-agency institutional practices to tie force structure with policy ends.[38]

The above observations, at both the global and local levels, problematize the Indian state's performance. The notion of a lagging response concerns the state's ability to create military power. As such it is different from and indirectly relates to military effectiveness. Studies of military effectiveness largely concern the military's institutional and organizational performance on the battlefield. Generally, such studies deal with the military's unit cohesion, tactical leadership, generalship, information management, technical skills, logistics, training, morale and so on.[39] In the fields of Sociology and military operations research, the focus of

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[37] K. Subrahmanyam, interview with author, October 2009 (Noida, India).

[38] Bharat Karnad, "Maturing Nuclear & Missile Capabilities," *India's Nuclear Policy* (Westport: Praeger Security International, 2008), pp. 63-106; Stephen P. Cohen & Sunil Dasgupta, *Arming Without Aiming: India's Military Modernization,* (New Delhi: Penguin, 2010), pp. 29-52, 97-122.

[39] Kenneth M. Pollack, "Understanding Arab Military Effectiveness," *Arabs at War: Military Effectiveness, 1948-1991* (Lincoln: Council on Foreign Relations, 2002), pp. 1-13.

military effectiveness is on the tactical or unit level of warfare. Political Scientists deal with broader categories: culture, social structure, domestic institutions, and the international system to assess military effectiveness.[40] But their focus too is the military's performance on the battlefield.[41]

Undoubtedly, the state's ability to create military power will have an effect on military effectiveness. However, state capacity precedes operational use on the ground. Furthermore, in the case of nuclear weapons, technical, institutional, and ideational capacities should be treated as a proxy for potential effectiveness because no military has used nuclear weapons after World War II. The term lag also resonates with but is different from Randall Schweller's concept of "underbalancing." Underbalancing, as Schweller describes it, is a "theory of mistakes." The "mistakes" in essence are the "non-balancing" or "inefficient balancing" behaviors of states against aggressive or unappeasable adversaries, which either provokes or prolongs a war that could have been avoided.[42] However, in my definition the touchstone of lag is not war. Rather, it is the state's underperformance.

Scholars of comparative politics often attribute variations in state performance to differentials in their infrastructural capacities. The latter can include: the 'strong state-weak state' typology, the state-society dialectic, the degree of state autonomy, the extent of state penetration of society, the state's ability to extract resources from its social base, the state's

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[40] Risa A. Brooks, "Introduction: The Impact of Culture, Society, Institutions, and International Forces on Military Effectiveness," in Risa A. Brooks & Elizabeth A. Stanley, eds., *Creating Military Power: The Sources of Military Effectiveness* (Stanford: Stanford University Press, 2007), pp. 1-9.
[41] Ibid.
[42] Randall L. Schweller, *Unanswered Threats: Political Constraints on the Balance of Power,* (Princeton: Princeton University Press, 2006), p. 10.

legitimacy, the state's ability to regulate society, the nature of a state's bureaucratic structures and so on.[43] However, the scope of my study sidesteps these analytic frames for several reasons. First, the post-colonial Indian state is above all a modern state in Weber's rational-legal meaning of the term. It enjoys a high degree of autonomy in functional areas such as foreign policy and national security. Whatever the degree of its fragmentation in the domestic sphere or its inability to carry out ambitious projects, the defense and nuclear sectors remain highly insulated and enable the state to conduct itself persuasively.[44] Moreover, if elections, peaceful transfers of power, and constitutional authority are used as metrics, then nearly all Indian central governments since 1947 have enjoyed political legitimacy. Whatever weaknesses may exist in the Indian state's relative revenue extraction capacity either against unrealized potential or when compared with peers, its absolute ability to finance self-identified strategic nuclear, space, and indigenous defense sectors has not suffered. In fact, the Indian state has consistently made large and stable revenue allocations to a group of scientific and industrial baronies devoted to developing nuclear, space, and advanced weapon systems.[45] These reasons apart, state-society balance metrics are useful for making comparative assessments of a society's cumulative capacity to generate military power, fight protracted hegemonic wars, or sustain long-term power rivalries in the international system.[46] But they have only secondary and tertiary effects on narrower sectors devoted to specialized tasks.

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[43] Janice Bially, Ashley J. Tellis, Christopher Layne & Melissa McPherson, "Measuring National Performance," *Measuring Power in the Postindustrial Age*, (Santa Monica: Rand, 2001), pp.102-122.

[44] Itty Abraham, "India's Strategic Enclave: Civilian Scientists & Military Technologies," *Armed Forces & Society*, Vol. 18, No. 2 (Winter 1992), pp. 231-252.

[45] Ibid.

[46] For example see, Stephen P. Rosen, *Societies and Military Power: India and Its Armies* (Ithaca: Cornell University Press, 1996).

In contrast, nuclear infrastructural capacities have an immediate tie to performance differentials. The scientific, technical, and engineering demands for fissile material production, weapons fabrication, testing, and deployment are vast.[47] States' inability to overcome bottlenecks in their scientific and technical infrastructure can impose significant delays. The long development timeline of Iran's enriched uranium production facilities and the faltering and now defunct Iraqi and Libyan nuclear weapon programs are cases that demonstrate this point. However, I exclude technical assessments of India's nuclear infrastructure as a cause for the lag in performance due to the presumption that India by 1974 had a proven capacity to produce fissile material as well as build at least simple fission devices. That said, it is not my purpose to argue that India's ascent up the nuclear weaponization ladder was frictionless. During the 1990s for example, the challenges of weaponizing and integrating nuclear weapons with delivery platforms proved formidable.[48] The evidence, however, suggests that these were second order problems that followed in the wake of political and institutional management practices. Therefore, an appraisal of the quality of India's strategic scientific and industrial infrastructure would only be in order if the scope of the research question concerned the size and sophistication of India's nuclear forces.

My scope conditions for lag primarily focus on the "software" side of security management, by which I mean the state's " policy capacity." Azar and Moon originally formulated the distinction between national security hardware and software. They categorized software as a mix of state legitimacy, integration and policy capacity. Because legitimacy and integration

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[47] "Technologies Underlying Weapons of Mass Destruction," *Office of Technology Assessment,* (Washington, D.C.: US Congress, 1993), pp. 119-180.
[48] Senior Indian Air Force officers (retd.) 'A' & 'B', non-attributable interviews by author, January & February 2010 (Gurgaon and Noida, India).

overlap with a state's political infrastructural capacities and only indirectly relate to nuclear weaponization in India's context, I exclude them from consideration.[49] I therefore zero in on *policy capacity*, which I define as the network of institutional and organizational arrangements that enable a state to formalize national values, identify threats, make national security determinations, formulate plans, coordinate an internal response, and implement policy.[50]

Case Selection and Method

In this dissertation I study three cases of Indian nuclear decision-making between 1980 and 2010. Each case study is an analysis of decision-making episodes that span the length of a decade: the 1980s, the 1990s and the period from 1998 until 2009. The first case concerns India's delayed weaponization. The second analyzes India's lack of an operational nuclear capability during the 1990s in the aftermath of acquiring nuclear weapons. The third traces India's slow march to resolve institutional and organizational anomalies in the management of its nuclear force in the wake of formal claims to nuclear status and international recognition as a *de facto* nuclear weapons power.

Within case studies are especially useful in domains such as proliferation where the N is small and the information concerning states' operational practices, especially among second-tier nuclear weapon powers, is scarce. It also helps control for history, culture, and the

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[49] Edward E. Azar & Chung-in Moon, "The 'Software' Side of Third World National Security," in Edward E. Azar & Chung-in Moon, eds., *National Security in the Third World: The Management of Internal and External Threats* (Aldershot: Edward Elgar Publishing, 1988), pp. 77-91.
[50] Ibid., pp. 91-98.

effects of structural economic and security variables.[51] The contextualized and structured

comparison keeps a leash on "conceptual stretching" and avoids the inclusion of cases that

are not analytically equivalent. By undertaking to study this humanly, messy, and compelling

real-world problem, I am not attempting to discover what Hempel described general

"covering laws."[52] Rather, my goal is to uncover middle-range intervening mechanisms and

processes that lie between the "start" and "finish" of phenomenon.[53] The approach I adopt

is especially relevant for sorting through the problem of "equifinality" where outcomes have

several explanations that lead to the same outcome.

In my study, I combine historical "process tracing," and elite interviewing methods to

establish the basis of argument. The process tracing method lends itself particularly well to

detailed historical investigations and is useful to understand the interaction between

leadership agency and systemic structure, leadership selection effects, sequential processes,

path dependencies and feedback loops.[54] Substantial data for my research were obtained

through elite interviews during the year I spent in India doing field research. Some of it

comes from the small number of senior civilian and defense officials who constituted India's

informal nuclear network in the 1990s, prior to Delhi's formally claiming nuclear status.

Other interview data comes from members of India's military elites and the newly formed

[51] James Mahoney, "Strategies of Causal Assessment," in James Mahoney and Dietrich Rueschemeyer eds., *Comparative Historical Analysis in the Social Sciences,* (Cambridge: Cambridge University Press, 2003), pp. 360-367.

[52] Alexander L. George and Andrew Bennett, *Case Studies and Theory Development in the Social Sciences*, (Cambridge: MIT Press, 2005), p. 7.

[53] For general arguments on the value of single- small-N studies see: Dietrich Rueschemeyer, "Can One or Few Cases Yield Theoretical Gains," in Mahoney and Rueschemeyer, *Comparative Historical Analysis in the Social Sciences*, 305-36; Paul Pierson and Theda Skocpol, "Historical Institutionalism in Contemporary Political Science," in Ira Katznelson and Helen V. Milner eds., *Political Science: State of the Discipline*, (New York: W.W. Norton & Company, 2002), pp. 713-718.

[54] George and Bennett, *Case Studies and Theory Development in the Social Sciences,* pp. 205-232.

Strategic Forces Command (SFC). Some of the interviews were obtained on record. But most officials agreed to be interviewed on condition of anonymity. The data presented in this study are unique to the extent that no archival material in India pertaining to and related to the nuclear weapons program has been opened to scholars or the public. Further, much of what passed as institutional knowledge of India's nuclear weapons program in the pre-1998 era was not committed to paper for security reasons. It was orally transmitted among members of the nuclear network never numbering more than a dozen individuals. Thus the data used in this project represents one of the first attempts to study India's nuclear weaponization and operational planning processes through means of oral history.

Alternative Explanations

Traditional explanations for Indian proliferation outcomes can be divided into two categories. In the first are "nuclear demand" explanations, which spell out the structural security imperatives that cause states to proliferate. These arguments are the most widely accepted explanations among the general public, academics and policy practitioners for India's nuclear state of affairs. However, because India's historical nuclear outcomes are empirically a poor fit with structural demand explanations, scholars have advanced a second set of "supply side" constraint arguments – prestige, normative-cultural and economic – to bridge the gap between the expected and actual outcomes. The demand side explanations are deductive and function at the level of the international system. The supply side explanations on the other hand are inductive and draw from the specific and peculiar meso-level constraints of the Indian state.

I take up swathes from these two sets of arguments below and show that neither offers a credible or consistent explanation for India's nuclear behavior.

NUCLEAR DEMAND SIDE ARGUMENTS

Defensive Realism

Structural Realism, especially its 'Defensive' variant, is the most widely accepted theoretical explanation for India's nuclear behavior. The theory's fundamental tenets, which barely need repeating, are that the structural condition of anarchy in the international system forces states to rely on the institution of self-help. Nuclear weapons, because of their enormous destructive power, are game changers in the international system. States therefore either ally themselves with nuclear weapon powers, seek the shelter of their nuclear umbrellas or develop nuclear weapons independently.[55] In this framework, India faced a negative security relationship with its two regional neighbors: China and Pakistan. When confronted with independent nuclear threats from both countries, as well as evidence of mounting nuclear collusion between them, Delhi decided to build a nuclear arsenal.[56]

The more nuanced Defensive Realist argument has been advanced by Paul who concedes that both Realism and Liberalism influence states' proliferation behavior.[57] He argues that unlike great powers, which are "greedy security maximizers," regional powers are "prudential

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[55] Kenneth N. Waltz, "The Spread of Nuclear Weapons: More May Be Better," *Adelphi Paper 171*, (London: IISS, 1981), pp. 7-8.

[56] Ashely J. Tellis, "Strategic Factors Affecting India's Nuclear Posture," *India's Emerging Nuclear Posture: Between Recessed and Ready Arsenal*, (Santa Monica: Rand, 2001), pp. 39-75; Sumit Ganguly, "India's Pathway to Pokhran II: The Prospects and Sources of New Delhi's Nuclear Weapons Program," *International Security*, Vol. 23, No. 4, (Spring 1999), pp. 148-177.

[57] Paul, "Explaining Nuclear Forbearance," *Power Versus Prudence: Why Nations Forgo Nuclear Weapons*, pp. 14-15.

realists." In their interactions with regional peers, they balance "interests, capabilities, and intentions" to avoid creating negative security dilemmas.[58] Paul's typologizes the international system into regions of "high," "medium" and "low" conflict characterized by differences in the nature of state rivalries and conflicts. Only states in regions of "protracted" and "enduring rivalries and conflict" are likely to follow the logic of "hard realism" and proliferate. States in regions of "medium" and "low" conflict will more likely be receptive to liberal norms and institutional incentives.[59] Unlike great powers, regional powers also do not proliferate easily. But those regional powers that harbor great power aspirations will have added incentives to acquire nuclear arms.[60] Thus in Paul's model and Structural Realism in general, India's decision to proliferate is a no brainer.

The problem with Structural Realism however is not the outcome but the outcome's delayed onset and its attenuated form in every decade since India initiated a nuclear weapons program. The historical evidence that India delayed weaponization until the late-1980s, well after Pakistan's nuclear advances, amid conditions of high political and military volatility, is puzzling. To be sure Indian scientists were working on "developing sophisticated nuclear weapons." Yet as B.G. Deshmukh who served as cabinet secretary and principal secretary to the prime minister subsequently disclosed, "…there was no major mission to integrate and manufacture deliverable systems."[61] Although this may sound like a trivial distinction to the non-technical observer, the developing of "technology" and the building of "technics" are distinct. Technology is "engineering know how, a practical knowledge of how natural principles can be put to work…" Technics on the other hand, are "actual tangible machines,

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[58] Ibid., pp. 15-16.
[59] Ibid., pp. 18-27.
[60] Ibid., p. 18.
[61] Deshmukh, "Keep the Faith."

apparatuses, and devices that are the product of labor and technology applied to natural resources."[62] The existence of the first is not interchangeable with the second. The Indian program illustrates this point well. Although 1989 was the start date for weaponization, the end date of its first phase was 1994. Further, it wasn't until 1995-96 that India achieved the means to deliver nuclear weapons safely and reliably via aircraft. There was thus a six to seven-year gap before technology could be transformed into technics.

Likewise, structural arguments cannot explain the gap in India's institutional capacities to manage nuclear operations in the 1990s. Nuclear operations share several common characteristics with any complex emergency management task. The first institutional and organizational challenge is to establish a "common knowledge base" and "common operating base."[63] In India, however, the tight compartmentalization of information regarding the weapons existence comported against establishing any shared understanding among all the players. Further, Neorealism has no answer for why institutional anomalies in India's higher military command and inter-agency coordination practices, so crucial to address security dilemmas, remain unresolved a decade after it publicly claimed nuclear power status and has been accepted as much by the world's other great powers. Essentially, Neorealism, like any good deductive theory, is concerned with parsimonious explanations and getting a few big things right. And the one big regularity it predicts is that states faced

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[62] Daniel Deudney, "Dividing Realism: Structural Realism versus Security on Nuclear Security and Proliferation, in, Zachary S. Davis & Benjamin Frankel, eds., *The Proliferation Puzzle: Why Nuclear Weapons Spread*, (Frank Cass, 1993), p. 22.

[63] For an overview of some of the challenges of inter-organizational coordination during extreme events and emergencies see, Louise K. Comfort, "Crisis Management in Hindsight: Cognition, Communication, Coordination and Control," *Public Administration Review,* (December 2007), pp. 189-197; _____, "Managing Intergovernmental Responses to Terrorism and Other Extreme Events," *Publius: The Journal of Federalism,* Vol. 32, No. 4, (Fall 2002), pp. 29-49.

with structural conditions of anarchy will balance against them. By that measure, the theory is correct. India has balanced and acquired nuclear weapons. Arguably, the debate is over. And yet, the theory tells us nothing about the timing and *content* of India's national security responses to structural pressures.

NUCLEAR "SUPPLY SIDE" CONSTRAINT ARGUMENTS

PRESTIGE

The most favored alternative explanation for India's nuclear behavior is that it is prestige-oriented. Scholars who make this argument draw on prestige theories from Classical Realism and Sociological New Institutionalism. They point to Classical Realists such as Morgenthau who emphasized the role of prestige as an instrument of power;[64] and Gilpin who referred to "prestige rather than power" as "the everyday currency in international relations."[65] Further back, theorists now considered the predecessors of modern Realism, Thucydides, Hobbes, Machiavelli, and Rousseau, also refer to prestige motivations as intrinsic ends in themselves.[66] This argument has parallels in Sociology's New Institutionalism literature, which makes the case that individuals and organizations mimic each other's behavior not because of underlying competitive pressures or functional logic, but because they feel the need to belong to a shared system of beliefs and ideas considered legitimate in particular time and space contexts.[67] The prestige theorists similarly rationalize that the Indian state has

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[64] Hans J. Morgenthau, *Politics Among Nations* (New York: Alfred A. Knopf, 1985), p. 95.

[65] Robert Gilpin, *War and Change in World Politics* (Cambridge: Cambridge University Press, 1981), p. 31.

[66] Daniel S. Markey, *The Prestige Motive in International Relations*, PhD Dissertation, (Princeton University, November 2000), pp. 19-31.

[67] Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," pp. 73-76.

never treated nuclear weapons as instrumental to address security dilemmas, but only sought them because they have became institutionalized as attributes of great power status. Karsten Frey sums up this logic when he says: "In India's nuclear policy formulation, status seeking became a national interest in its own right…not by increasing the substance of state power…but by displaying it."[68]

The prestige argument is rich in evidence. But it ignores something very basic, which is that prestige depends on public knowledge of the possession of a value or material object held in esteem because of its relative scarcity.[69] However, for nearly a decade (1989-1998) before India ended its policy of nuclear ambiguity, the weaponization program unfolded in secrecy within the state. The latter reality undermines the basic operating principle of prestige, which is publicity. In India's case, scholars sometimes collapse the intrinsic and instrumental ends or prestige. At other times they parse them. In the intrinsic argument, nuclear weapons are associated with the post-colonial Indian state's foundational notions of legitimacy and modern identity. Scholars such as Abraham and Krishna cast nuclear weapons as artifacts of modernity that dignify and satisfy the primordial nationalist urges of the subaltern post-colonial Indian state.[70] Indeed, cultural, anthropological and sociological scholarship has unpacked the cultural meanings and symbolisms associated with nuclear weapons in the collective consciousness of Indian publics and elites. However, it is impossible to tease out semiotic associations from the more tangible national security drivers behind policies. This

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[68] Frey, "Conclusion," *India's Nuclear Bomb and National Security,* p. 197.
[69] Barry O'Neil, "Nuclear Weapons and the Pursuit of Prestige," May 2002, http://www.sscnet.ucla.edu/polisci/faculty/boneill/prestap5.pdf (May 2011).
[70] Abraham, "Introduction," *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*, pp. 17-30; Sankaran Krishna, "The Social Life of a Bomb: India and the Ontology of an "Overpopulated" Society," in Itty Abraham ed., *South Asian Cultures of the Bomb: Atomic Publics and the State in India and Pakistan*, (Bloomington: Indiana University Press, 2009).

literature is also embedded in a "soft" epistemology, which makes the task of measurement and establishment of causal links to specific outcomes difficult.[71]

The instrumental argument in comparison has measurable domestic and external goals. For example, Markey and Bajpai attribute India's 1998 decision to conduct nuclear tests and claim nuclear power status to the rise of Hindu nationalism and the Hindu-nationalist Bharatiya Janata Party's (BJP) demands for electoral dividends. The trouble with this argument is that it ignores the simple historical counterfactual that six prime ministers at the head of four centrist and left-of-the center coalitions supported the weaponization program for a decade prior to the 1998 tests. In fact, the tests would have been impossible without their support. Three prime ministers verged on tests: in 1982-83,[72] in 1995[73] and in 1996[74] before finally ordering them in 1998. To be sure, the tests proved enormously popular and the Hindu nationalists reaped electoral dividends from them.[75] However, this phenomenon in and by itself does not establish causality.

On the other hand, Frey's external prestige argument maintains that nuclear weapons are the petard with which India has sought entry into the exclusive club of nuclear great powers. To establish this claim, Frey uses the elite discourse analysis method. His evidence consists of a random sample of 705 nuclear-related editorials and opinions culled from four Indian newspapers between 1986-2005. This sample shows that the Indian elite discourse focused

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[71] Landmark works include: Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State; _____, ed., South Asian Cultures of the Bomb: Atomic Publics and the State in India and Pakistan.*

[72] Perkovich, "More Robust Nuclear Policy Is Considered," *India's Nuclear Bomb*, pp. 242-243.

[73] Perkovich, "India Verges On Tests," *India's Nuclear Bomb,* pp. 364-371.

[74] Ibid., pp. 374-376.

[75] Bajpai, "The BJP and the Bomb," in Sagan ed., *Inside Nuclear South Asia,* pp. 49-57.

on security threats during the 1980s, shifted attention to the nonproliferation regime and identity-related status issues in the 1990s, reverted back to security issues in the wake of 1998 tests, and thereafter once again became fixated with status and identity issues.[76] Over 20 years, concerns of self, identity and prestige outpaced national security threats in the public discourse.[77] Frey treats this shifting elite discourse as a proxy for Indian decision-makers' beliefs and priorities.

However, there are two reasons why Frey's argument is unpersuasive. First, it does not account for the alternative causal logic that punditry takes its cues from and has an interactive relationship with historical events and trends. Second, he proposes without any supporting evidence that because the Indian state lacked an institutionalized national security decision-making apparatus, the strategic elite outside government was "able to monopolize the security discourse and thus hold an element of power which, in a Habermasian definition, comprises both 'communicative power' and 'administrative power' associated with the functions and institutions of the state."[78] This latter assumption vastly overestimates the elite's capacity to influence the state and underestimates the zealousness with which the Indian executive has historically guarded its prerogative over nuclear decision-making.

Thus the prestige advocates err on three counts. First, they ignore the reality that prestige associated with nuclear weapons has been a constant in Indian politics since the 1974 nuclear test. All prime ministers from 1983 on had the option to test and yet none chose to do so until 1998. Second, prestige depends on publicity. Yet, seven Indian governments between

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[76] Frey, "Elite Perception and India's Nuclear Course: Tracking the Empirical Evidence," *India's Nuclear Bomb and National Security*, pp. 28-46.

[77] Ibid., pp. 44-46.

[78] Frey, "Elite Perception and India's Nuclear Course," p. 30.

1989 and 1998 elected against making India's nuclear capability public. And finally, nuclear issues have ceased to be an electoral issue in Indian politics. But for the technical milestones such as platform acquisitions and missile tests that are visible to the general public eye, the more substantial organizational, institutional and ideational elements of nuclear force development have once again receded into the background. Finally, the instrumentalists' surmise that India has sought nuclear weapons for display purposes is contradicted by the steady development of India's nuclear force capabilities in the last decade even after being accepted as a "responsible state with advanced nuclear technology."[79]

Normative-Cultural

Aside from Classical Realist and sociological arguments, a case is often made that Indian leaders have sought prestige by abjuring what would be considered the normal behavior of security seeking states in the international system. Scholars maintain that Indian leaders have sought to position India as a moral exemplar; as a country that stands aloof and above the riff-raff of security maximizers.[80] Indeed, Indian prime ministers until the late-1970s, Nehru, Shastri and Desai, had a strong aversion to nuclear weapons and institutionalized their preferences through the state's public advocacy of global nuclear arms control and disarmament; as well as by rejecting domestic pressures for nuclear armament.[81] There is also evidence to show that the two key nuclear decision-makers in the 1980s, Prime Ministers Indira and Rajiv Gandhi, opposed weaponization on normative grounds.

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[79] "Indo-US Joint Statement," July 18, 2005, http://www.hindu.com/thehindu/nic/indousjoint.htm, (July 2005).
[80] Perkovich, "Conclusion," *India's Nuclear Bomb*, pp. 448-449.
[81] Rajesh M. Basrur, "Strategic Culture," *Minimum Deterrence and India's Nuclear Security*, (Stanford: Stanford University Press, 2006), pp. 60-62; Perkovich, *India's Nuclear Bomb*, pp. 83-85, 199-204, 209-216.

However, the evidence is more muddied. Although senior policy planners who interacted with Rajiv Gandhi have described him a "reluctant believer" in the nuclear cause,[82] his mother and immediate predecessor's motives appear to be a mixed bag of economic realism and political risk-aversion.[83] That said, even Rajiv Gandhi followed a Janus-faced approach, which coupled moralism with an insurance strategy of allowing work on the weapon program to proceed.[84] But more substantially, prime ministers who succeeded the Gandhis after 1989 do not appear to have shared their normative predilections. India had a succession of six prime ministers in the period 1989-1998. At least three among them, Singh, Rao, and Gowda, cited economic constraints for not conducting nuclear tests.[85] Further, all prime ministers from 1989 on, including Rajiv Gandhi, privately supported the weaponization program. Thus the historical evidence shows variation between decision-makers' public statements and private actions.

The above normative argument also does not distinguish between "consequential actions," by which actors consciously resort to agency to achieve identified ends from what Sociological Institutionalism categorizes "obligatory" action by which actors ritualistically comply with "scripts" and "playbooks" deemed socially appropriate.[86] Oddly in 1998, three decision-makers at the helm of the BJP-led government (Vajpayee, Advani, and Singh) succeeded in revolutionizing the course of the state's nuclear policy. Such a revolutionary

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[82] Chengappa, "The Reluctant Believer," *Weapons of Peace*, pp. 291-305.

[83] Perkovich, "More Robust Nuclear Policy Is Considered," *India's Nuclear Bomb*, pp. 242-244; Chengappa, "Do You Want Our Skulls Cracked?" *Weapons of Peace,* pp. 246-261.

[84] Chengappa, "The Reluctant Believer," pp. 303-305.

[85] Ibid., pp. 353-361, 367-371, 396-400; H.D. Deve Gowda, "Dear Prime Minister Sri Vajpayeeji," *Rediff on the Net,* May 22, 1998, http://www.rediff.com/news/1998/may/22deve.htm, (June 2013).

[86] Peter A. Hall and Rosemary C.R. Taylor, "Political Science and the Three New Institutionalisms," *Political Studies* XLIV (1996), pp. 946-950.

action course would have been impossible had nuclear abstinence norms been deeply institutionalized within Indian state and society. This brings us to the third problem with the normative argument, which is, that it effectively black boxes the state. Indeed, if we peer inside the black box of the state, we discover considerable opposition from scientist-bureaucrats and military leaders who viewed Pakistan's nuclear advances in the 1980s and 1990s with consternation and pushed for a hard Realist course of action.[87] Hence the normative question inevitably takes an institutional turn: what were the permissive institutional conditions that enabled single actors to veto opposition within a legal-rational state apparatus?

Coinciding with the post-Cold War wave of ideational-normative studies in international security,[88] South Asian security studies scholarship has also embraced meso-level cultural variables to supplement the minimalism of deductive theories.[89] The argument advanced is that India's normatively freighted strategic culture exercises explicit and tacit restraints on military maximalism.[90] Although this argument is generally popular with academics and policy makers, considerable confusion abounds on whether the sources of cultural preferences that inform Indian strategic thinking are institutional or normative. It is also

[87] B. G. Deshmukh, "Economic and Defense Matters," *From Poona to the Prime Minister's Office: A Cabinet Secretary Looks Back,* (New Delhi: Harper Collins Publishers India, 2004), pp. 163-166; Chengappa, "Do You Want Our Skulls Cracked?" pp. 256-247, 257-261.

[88] For a general literature review see: Michael C. Desch, "Culture Clash: Assessing the Importance of Ideas in Security Studies," *International Security,* Vol. 23, No. 1 (Summer 1998), pp. 141-170.

[89] Examples include: George Tanham, *Securing India: Strategic Thought and Practice* (New Delhi: Manohar, 1996); Jaswant Singh, *Defending India,* (Bangalore: Macmillan Press India, 1999); Michael R. Chambers ed., *South Asia in 2020: Future Strategic Balances and Alliances,* (Carlisle: Strategic Studies Institute: U.S. Army War College, 2002); Basrur, *Minimum Deterrence and India's Nuclear Security.*

[90] The most recent articulation of this argument is contained in, Stephen P. Cohen and Sunil Dasgupta, *Arming Without Aiming: India's Military Modernization,* (Washington, DC: The Brookings Institution, 2010).

unclear if the strategic culture argument applies to 'grand strategy', which is the "purposeful

employment of all instruments of power available to a security community,"[91] or the

narrower 'military strategy', which pertains to the planning and execution by military

organizations of strategic goals.[92] In the absence of such specifications, the purchase of the

strategic culture argument is unclear. Nuclear policy is referred to in a general way in many

arguments. Some scholars have tied an entire stable of cultural preferences and beliefs

(Nehru-Gandhi) to at least three evolving nuclear tableaus (option, recessed deterrence and

overt posture) from the early1980s to the last decade.[93] However, this attempt undermines

the argument that cultural belief systems explain India's nuclear consistency and restraint in

the face of system-level pressures.

The debate on cultural explanations for India's strategic behavior was triggered by Tanham's

controversial claim in the early 1990s that India suffered from the "absence of strategic

thinking." When making this claim, Tanham made no distinction between grand strategy and

military strategy. He also based his claims on a mix of historical and cultural factors. At the

historic plane, Tanham asserted that India lacked imperial unity for most of its history.

Because it did not evolve into a modern state independently, it never developed a tradition

of thinking about "national defense." However, the dominant reasons behind his claims are

cultural: the Hindu "concept" or the "lack of a sense of time" and the treatment of life as

vague and "mysterious." The latter, Tanham maintained, discouraged planning.[94] The

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[91] Colin Gray, "Conclusion," *War, Peace and International Relations – An Introduction to Strategic History* (Oxon: Routledge, 2007), p. 283.

[92] Scott Sigmund Gartner, "Decision Making In War," *Strategic Assessment in War* (New Haven: Yale University Press, 1999), p. 163.

[93] Basrur, "Nuclear Weapons and Indian Strategic Culture," *Journal of Peace Research,* Vol. 38, No. 2 (March 2001), pp. 181-198.

[94] Tanham, *Securing India: Strategic Thought and Practice*, pp. 72-75.

difficulty with the historical frame is that it ignores the two centuries of the British imperial

interlude, the strategic planning that accompanied empire and the post-colonial Indian state's

inheritance of both the imperial institutions as well as the imperial mindset. The cultural

arguments also do not account for the materiality of the post-colonial Indian state and its

primary post-independence project: centralized economic planning and development.[95]

Although Tanham never drew causal links between his claims on the "absence of strategic

thinking" and Indian nuclear policy, leading Indian strategic thinkers such as K.

Subrahmanyam and India's former foreign minister Jaswant Singh used it to frame what they

described as the drift in India's nuclear policy. However, a close study of Subrahmanyam's

writings show that both institutional and cultural reasons account for that drift; and that

institutional reasons are the primary and culture the secondary.[96] Singh, on the other hand,

accepted the validity of Tanham's reasons but argued that India's failings were specific to

'grand' strategy and not 'military' strategy.[97] Whereas Subrahmanyam's institutional critiques

of Indian policy planning, borne out of his own experience in government, eclipse the

cultural argument, Singh's criticisms have greater applicability to the grand strategic

principles governing India's nuclear posture (covert versus overt) and the handling of

nonproliferation pressures in general. They apply less to the specifics of covert nuclear

developments and related operational planning. More significant, Singh's thesis highlights

the institutional path dependency problems that arose from the personal and non-

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[95] See for example, Sunil Khilnani, "Temples of the Future," *The Idea of India,* (New York: Farrar, Straus & Giroux, 1997), pp. 61-106.

[96] For a snapshot see, K. Subrahmanyam with Arthur Monteiro, "Does India Have a Strategic Perspective?" *Shedding Shibboleths: India's Evolving Strategic Outlook* (Delhi: Wordsmiths, 2005), pp. 1-28.

[97] Jaswant Singh, "Strategic Culture," *Defending India*, (Bangalore: Macmillan India Limited, 1999), p. 14.

institutionalized system of foreign policy and strategic decision-making in the first two decades of Indian independence.[98]

To date, Rajesh Basrur has applied the strategic cultural argument most rigorously. He restricts his argument to a select historical window, narrows its scope to nuclear weapons excluding all other strategic questions, and develops a credible methodology of specified open-source content analysis and elite interviews to support his case.[99] Basrur identifies three elements in Indian strategic culture, which he argues are the basis for the continuing nuclear minimalism and restraint from the late 1970s until the early 2000s. These are: (a) a very limited acceptance of nuclear weapons as a source of national security; (b) political as against the technical/operational understanding of nuclear weapons; and (c) incremental responses to systemic-level structural pressures to expand nuclear capabilities.[100] It is this restrained strategic culture, the "habits of mind, traditions, and preferred methods of operation," argues Basrur, which explains the slow institutional changes in India's nuclear responses: the options posture in the 1980s; the recessed posture in the 1990s; and the overt posture post-1998.[101] Remarkably enough, Basur characterizes the tectonic institutional shift between the recessed (pre-1998) and overt (post-1998) postures as non-radical, because of the general reluctance of the political class to develop an operational capability.[102] Thus cultural preferences in his view are the connective thread that tie three nuclear institutional postures and explain overall restraint.

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[98] Ibid., pp. 22-58.
[99] Basrur, "Strategic Culture," *Minimum Deterrence and India's Nuclear Security,* pp. 57-59.
[100] Ibid., p. 58.
[101] Ibid., pp. 60-65.
[102] Ibid., pp. 64-65.

Basrur's methodology, however, unearths something entirely at odds with his argument. It shows that the Indian elite's post-1998 nuclear beliefs and preferences are dichotomized along two lines: between the politicians who view nuclear weapons as political weapons and the strategic experts and the military who lean in the direction of espousing an operational framework for those same weapons.[103] In essence, Basrur's methodology reveals evidence of the existence of two competing sub-cultures within the Indian state, which uneasily cohabit a common political space. Although Basrur's data are restricted to the post-1998 years, his methodology when applied to earlier historical periods – the decades of the 'option' and 'recessed' posture – shows a similar cultural dichotomy between the political generalists and the professional military.[104]

In advancing the cultural argument, Basrur bucks the obvious institutional and organizational ones. In a regime of competing sub-cultures what conditions enable one set of cultural beliefs to prevail in the policy market place? Similarly, in a system characterized by cultural differences, why is there a systemic bias in favor of the status quo? Basrur indirectly answers these questions by showing that pre-1998 nuclear decision-making in India was the exclusive preserve of the prime minister to the exclusion of parliament, the civilian bureaucracy, the military and public opinion. By his own admission, India's strategic culture is reduced to a set of cultural preferences held by prime ministerial incumbents,[105] a process which black boxes the state. Finally, and more significant perhaps, Basrur admits to the

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[103] Ibid., pp. 67-73.
[104] For example see, General K. Sundarji, *Blind Men of Hindoostan* (New Delhi: UBS Publishers, 1993); Deshmukh, "Economic and Defense Matters," pp. 164-166.
[105] Ibid., pp. 66-67.

gradual shift toward an operational bias in Indian strategic culture[106] without accounting for the mechanisms behind new cultural learning in the system.

Economic

The final set of "supply side" constraint arguments concern the economics of nuclear restraint. This set has two variants. The first concerns India's economic constraints. The second argument is metaphorically akin to Putnam's "two-level game" model[107] where the outward/inward orientation of domestic political coalitions shapes the politics of nuclear restraint. The strictly domestic level argument is that India's weak resource conditions explain nuclear restraint in the years 1980-98. In 1982-1983 for example, Prime Minister Indira Gandhi reportedly canceled earlier planned nuclear tests due to the implicit threat of US denial of World Bank and IMF funds.[108] Similarly in 1985, Prime Minister Rajiv Gandhi also shelved plans prepared by an interdisciplinary team consisting of scientists and the military for a proposed nuclear arsenal because he thought its budgetary price too high.[109] Similarly, Prime Minister Rao considered a program of nuclear tests in 1995-96. But he decided against it lest the tests jeopardize the "structural adjustment" program then underway with the IMF's assistance.[110]

The economic constraints argument therefore credibly explains India's reluctance to conduct hot tests and embrace an overt nuclear posture until 1998. However, it does not address the

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[106] Ibid., pp. 75-77.

[107] Robert D. Putnam, "Diplomacy and Domestic Politics: The Logic of Two-Level Games," *International Organization*, Vol. 42, No. 3, (Summer 1988), pp. 427-460.

[108] Perkovich, "More Robust Nuclear Policy is Considered," *India's Nuclear Bomb*, pp. 242-244.

[109] Ibid., pp. 273-276; Chengappa, "The Reluctant Believer," *Weapons of Peace*, pp. 297-305.

[110] Perkovich, "India Verges on Nuclear Tests," *India's Nuclear Bomb*, pp. 353-377.

puzzles I raise, which concern weaponization adjusted to the economic constraints of the time. Resource constraints, furthermore, should not impact operational planning, which is a software issue that concerns intra- and inter-agency coordination and planning. More significant, during the last decade, economic constraints in the form of threatened US sanctions have ended with Washington's acceptance of New Delhi's *de facto* nuclear weapon power status. Likewise, the Indian economy's "tiger" performance in the last decade has loosened the government's purse strings on military spending. However, even as these externalities have changed, institutional and organizational lacunae in India's operational posture remain; effectively scuttling the economic constraints as the cause for Indian nuclear restraint argument.

Etel Solingen has advanced the second economic argument. Solingen highlights the link between the orientation of domestic coalitions and grand strategy. Extending the analytic treatment that Jack Snyder and Mathew Evangelista applied to the domestic politics of great powers in the realms of war making and weapons procurement, she argues that nonproliferation outcomes are more likely to emanate from the economic practices of liberalizing domestic coalitions.[111] In the context of nuclear proliferation Solingen makes two specific claims. First, domestic liberalizing coalitions care about access to international financial markets, trade, capital, and investments. Such coalitions are aware that non-acceptance of full-scope nuclear safeguards can result in the denial of access to the global economy.[112] Second, nuclear weapon programs are usually bound up with domestic inward looking "nationalist-confessional" coalitions. In contrast, liberalizers tend to de-regulate the

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[111] Etel Solingen, "The Political Economy of Nuclear Restraint," *International Security*, Vol. 19, No. 2, (Autumn 1994), pp. 136-142.
[112] Etel Solingen, "Alternative Logics on Denuclearization," *Nuclear Logics: Contrasting Paths in East Asia and the Middle East,* (Princeton: Princeton University Press, 2007), pp. 40-41.

economy and disinvest in state-controlled strategic industrial sectors. The implications for nuclear weapon programs and the nuclear complex in general are that state liberalization of the economy and withdrawal from public sector industries will likely generate pressures that favor termination of nuclear weapon programs.[113]

Solingen caveats her argument by cautioning that her theory is more probabilistic than deterministic and that her models are more in the nature of Weber's "ideal types;" conceptual constructs and not "historical or true realities." Furthermore, leaders' ability to successfully implement liberalizing agendas will vary according to their strength vis-à-vis domestic competitors as well as whether neighboring regional states adopt similar liberalizing agendas. Equally significant, the temporal sequences surrounding nuclear weapons acquisition matter. Hence, the argument does not apply once critical nuclear thresholds are crossed. For example, leaders will find it harder to give up the weapons they may already possess than abandon steps in the direction of weapons acquisition already taken.[114]

There is however, little empirical support for Solingen's claims. Sasikumar and Way's hazard model shows for instance that trade liberalization is associated with higher risks of nuclear proliferation. Further, the expansion in gross domestic product (GDP) has a non-linear relationship with states' nuclear quest. Per capita GDP expansion only above very high thresholds is likely to reduce the risk of nuclear proliferation. Higher levels of trade

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[113] Ibid., pp. 41-42.

[114] Solingen, *Nuclear Logics,* pp. 17-20, 44-45.

openness, to be sure, reduce the hazard. But participation in international regimes and organizations do not appear to inhibit proliferation.[115]

Solingen's test cases are restricted to states in the Far and the Middle East. Her study excludes India and Pakistan. Nonetheless, India is an important test case because it meets all her theory's scope conditions: liberalizing coalition, effective domestic leadership, neighboring states with liberalizing agendas and a weaponization program in an inchoate phase. It also turns out to be the case, which strongly refutes the liberalization as the means for de-nuclearization thesis. The weaponization phase of India's nuclear weapons program in 1989 almost precisely overlapped with the launch of economic liberalization policies in the late 1980s. In the two decades following that decision, the weaponization program's scope has expanded even as the orientation of the Indian economy has taken an almost irreversible global turn.

To summarize the main points: the nuclear demand explanations focus on the role security competition plays in forming states' nuclear preferences. In India's case, however, they are unable to explain the lag in the actualization of those preferences. The nuclear "supply side" constraint arguments attempt to fill that gap by drawing on India-specific domestic explanations. Among them, prestige arguments ignore counterfactuals and read the evidence selectively. Normative accounts conflate the state's norms with those held by prime ministerial incumbents. Cultural arguments, on the other hand, are unable to decide whether the source of India's strategic culture is structural, normative or institutional. Such arguments also ignore the institutional elephant in the room, which offers the obvious explanation for

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[115] Sasikumar and Way, "Testing Theories of Proliferation in South Asia," in Scott D. Sagan ed., *Inside Nuclear South Asia,* (Stanford: Stanford University Press, 2009), pp.79-81.

why in the midst of competing sub-cultures, one prevails over the other. Finally, economic constraint arguments are irrelevant to the issue of covert small-scale weaponization programs, institutional planning and organizational coordination. Moreover, India's rapid economic growth in the last decade, its huge expansion in defense spending including spending in the strategic nuclear sector and the removal of the threat of external sanctions, all disabuse the idea of economics as the cause for the lag in India's nuclear performance.

Overview of the Dissertation

In the following chapters I develop the theoretical scope of my argument and present empirical evidence to support it.

Chapter 2 fleshes out the concept of "regimes of ignorance" and how such regimes retard learning in covertly proliferating states. I argue that strongly institutionalized epistemic communities, structured and open decision-making processes and organizational transparency are essential for state learning. Epistemic actors are essential to building well-developed information and corresponding knowledge markets inside states, conditions necessary for informed decision-making. Structured decision-making processes that are also open to independent peer review reduce the scope for heuristics and biases in decisions. Similarly, organizational transparency and high information turnover create permissive conditions for political principals to effectively monitor their agents. Learning in state actors and agencies, which I define as the incorporation of new routines into existing institutional practices, will be spasmodic when such institutional and organizational processes are absent or weakly developed.

Chapter 3 revisits the puzzle of India's delayed weaponization in the 1980s. I highlight the challenges of imperfect information and uncertainty that confront most decision-makers; and how weakly institutionalized epistemic actors and poorly developed information and knowledge markets compound the challenges of accurately assessing national security threats. I show that India's sequential problem solving approach and the decision-makers' underestimation of the severity of Pakistan's challenge are directly traceable to the unstructured information processing and national security decision-making system in the state. Further, Indian decision-makers' overestimation of the Indian state's domestic capacity to counter that threat bespeaks of the problems of effective agent monitoring in regimes of information compartmentalization and scarcity.

Chapter 4 dwells on India's problems of nuclear operational planning under domestic institutions of secrecy and international scrutiny in the decade of the 1990s. In it I present evidence to show the linkages between poor knowledge aggregation within the state and the absence of deductive planning. In India's case, these directly contributed to many of the technical and organizational hurdles that hampered execution of the weaponization project during the 1990s. I also show that decision-makers' cognitive biases were the cause for the absence of inter-agency planning and coordination on soft nuclear operational routines in this period. Information asymmetries and the decision-makers' lack of effective oversight over their agents were also the direct consequence of the state's internal regime of ignorance. I conclude by showing that external assumptions to the contrary, India lacked an operational nuclear capability until the summer of 1999.

Chapter 5 examines the path dependency effects of existing institutions even after decision-makers commit to new policy goals. I show how weakly instituted epistemic communities and compartmentalized planning adversely affected the actualization of nuclear operational practices in the first half of the decade following India's formal claims to nuclear power status; and how stronger institutions in the latter half of the decade gradually changed outcomes. The anchoring effects of heuristics and biases are nowhere more evident than in the internal debate on the political versus operational understanding of nuclear weapons. I also present evidence to show that many of the technical and organizational bottlenecks that come in the way of smooth operational practices stem from classic principal-agent problems.

Chapter 6, the concluding chapter, expands the framework I have developed in this dissertation to study other cases of proliferation in the international system. I argue that among all nuclear weapon powers, India's case stands out as an exception. But the causality for Indian exceptionalism does not run through either the nature of India's bureaucracy or its civil-military institutions. Rather the cause for the difference between India's nuclear performance and that of nuclear weapon powers stems from variation in the institution of secrecy that states institute domestically to manage their nuclear weapon programs. In this regard, I conceptualize secrecy as a continuum - low, medium and high - along two axes: internal and external. I argue that high external secrecy has a less debilitating impact on the domestic management of the program than a corresponding regime of high internal secrecy. The two are no doubt interlinked. A state most concerned with hiding its proliferation effort from external scrutiny will also be inclined to keep it under tight wraps domestically. Correspondingly, a state less concerned with external secrecy will have more breathing room for establishing institutionalized management controls within. A lower degree of domestic

secrecy also creates more institutional space for structured decision-making and parallel

problem solving across multiple agencies within the state.

CHAPTER TWO

STATE LEARNING AND A REGIME OF IGNORANCE

After sitting astride the nuclear fence for over two decades, India in 1998 finally elected to join the ranks of declared nuclear weapon powers citing national security reasons.[116] In the decade following that decision, New Delhi has doubled down on its attempts to acquire the technical and organizational accoutrements of an operational arsenal. This is a work in progress and serious technical, institutional and organizational lacunae in India's operational capabilities remain at large. Nonetheless, the act of putting money where one's mouth is, has confirmed the logic of the Neorealist observation that states generally proliferate to manage the problem of nuclear uncertainty.

However, India's nuclear fence sitting, the longest in any nuclear weapon power's history, raises serious questions about the fidelity of Neorealist theory's fundamental observation that states respond to structural pressures through external and internal balancing. New Delhi's irresolution opened the door to a host of rival explanations. These latter explanations variously linked India's nuclear behavior to peaceful norms, strategic culture, prestige and the political economy of strategic restraint. Without doubt, each of these explanations holds some water. For example, Indian decision-makers insist on the impossibility of any nuclear exchange while simultaneously engaged in an ambitious nuclear build up. Indian strategic elites often refer to India's 'Hindu' culture to rationalize the lag in its operational nuclear posture. Public opinion surveys consistently reflect the pride India's urban middle classes

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[116] "Nuclear Anxiety: Indian's Letter to Clinton on the Nuclear Testing," *New York Times,* (May 13, 1998), http://www.nytimes.com/1998/05/13/world/nuclear-anxiety-indian-s-letter-to-clinton-on-the-nuclear-testing.html, (November 2012).

express in the country's nuclear arsenal. And there is substantial evidence that India's decisions to delay nuclear tests and prevaricate on an overt nuclear posture until 1998 were the consequence of perceived economic constraints on the part of prime ministerial incumbents.

Yet, as I explained in the introductory chapter, none of these explanations offers an argument that is internally consistent or consistent with the historical evidence. The norms argument is at odds with evidence of the Indian state's firm private commitment to a weaponization program from 1989 onward. This is also something fundamentally wrong with the strategic culture argument. Cultures are viscous. They are resilient to change. If a cultural consensus on the symbolic nature of nuclear weapons had been widely prevalent within the Indian state, four decision-makers in 1998 would have found it difficult, if not impossible, to irretrievably turn the nuclear direction of the ship of state on an operational course. Similarly, the political economy of restraint is a reasonable explanation for India's hesitation to make overt and formal claims to nuclear power status. However, it is a weak explanation for the absence of intra- and inter-agency planning to give existing weapons operational punch. Furthermore, the economic constraints have dissipated in the last decade. Nevertheless, the continued prevalence of lacunae in India's soft operational routines suggests that there are other causes for these lags.

With more evidence now available on the covert nuclear weapon program in the two decades prior to the 1998 tests, the norms, strategic culture and prestige arguments are more or less disproven. Much of the evidence points to national security rationales, a point compellingly made in 1998 and thereafter. In that sense, Neorealism is the most persuasive

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residual explanation for Indian proliferation. And yet, although the broad contours of Indian nuclear outcomes conform to the Neorealist logic, the details of Indian nuclear behavior are cause for puzzlement. The three puzzles: India's delayed weaponization during the 1980s despite an unambiguous nuclear threat from Pakistan, the underdeveloped soft routines following weaponization during the 1990s, and more bafflingly still, the delays in infrastructure investments and the intra- and inter-agency coordination gaps in the last decade, cannot be reconciled with Neorealist expectations. To be sure, the argument that operational gaps are inevitable when countries proliferate covertly may have some validity, the same does not hold true for the present era. Especially in light of India's international embrace as a *de facto* nuclear weapons power and the rapid advances in Pakistan's operational capabilities amid a series of nuclear crises in South Asia.

The problem with Neorealism is that it takes "auxiliary" mechanisms inside states for granted; the socialization and learning mechanisms that generate the outcomes the theory predicts will occur in response to systemic pressures. Essentially, Neorealism has a very thin theory of socialization. It conflates states' adaptation to structural pressures with learning. But adaptation is not tantamount to either socialization or learning. The latter entail a fundamental change in the values and belief systems of actors making the adjustment.[117] Adaptation to systemic pressures may or may not stem from changes in values and belief systems. It may occur due to coercion or strategic calculation.[118] Also problematic is the

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[117] Jack Levy, "Learning and Foreign Policy: Sweeping a Conceptual Minefield," *International Organization,* Vol. 48 No. 2, (Spring 1994), p. 283.

[118] For an overview on the practices of socialization see, Jeffrey T. Checkel, "Why Comply? Social Learning and European Identity Change," *International Organization,* Vol. 55, No. 3, (Summer 2001), pp. 556-564; "International Institutions and Socialization in Europe: Introduction and Framework," *International Organization,* Vol. 59, No. 4, (Autumn 2005), pp. 804-813.

theory's assumption that state responses to structural pressures are nearly identical. In doing so, Neorealism subsumes rational choice, which imposes exogenous preference orderings on all decision-makers across the system without accounting for distortions. The heroic assumption behind this reasoning is that all states are socialized into isomorphic beliefs and practices, which emanate from the most successful states in the international system.[119]

International selection and socialization, Waltz argues, are the mechanisms, which ensure that states mimic each other. Those states that do not keep up with their peers face punishment and decline in power for not doing so.[120] States also mimic the example of their most successful peers in the international system. In the context of nuclear proliferation though, socialization pressures work in reverse. Although the competitive example of the most powerful states in the international system is nuclear proliferation, the socialization pressures generated through the nonproliferation regime penalize states for replicating those power institutions.[121] The standard channels of socialization that states usually rely on, governments and international organizations, are blocked. Structural theories are therefore at a loss to explain how the process of socialization unfolds within proliferating states.

State Learning

How then do proliferating states learn? In this chapter I develop a theoretical framework to map the process of states' internal learning practices. Learning, as I explain above is the modification of existing knowledge or the acquisition of new knowledge and its

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[119] Ibid.
[120] Kenneth N. Waltz, "Reductionist and Systemic Theories," in Robert O. Keohane ed., *Neorealism and Its Critics*, (New York: Columbia University Press, 1986), pp. 64-67.
[121] For a theoretical framework that unpacks how international institutions socialize states', see Checkel, "International Institutions and Socialization in Europe: Introduction and Framework," pp. 804-813.

institutionalization into a state's habitual routines. Learning can be experiential, can stem

from policy successes or failures, may occur due to a generational change in leadership or be

induced through the success of epistemic actors in socializing decision-makers into new

beliefs and practices.[122] In my framework, I am more interested in how states "learn to

learn."[123] What I mean by the latter is the socialization process that occurs through: (a)

interaction between epistemic actors and decision-makers, the appeal of arguments and

persuasion;[124] and (b) institutional and organizational reforms that enable states adopt better

analytic techniques, methodologies and processes to solve problems.[125] My framework of

learning also incorporates Philip Tetlock's "efficiency" criterion in which the measure of

learning is the ability of state leaders to change their belief systems in a manner that reflects

the world more accurately and their policy decisions offer a better fit between means and

ends.[126] I use the phrase "state learning" metaphorically because all learning takes place at the

level of individuals. Any state learning that occurs depends on the extent to which

individuals are successful in transforming their beliefs and practices into routine practices at

the institutional and organizational levels.[127]

I maintain that the process of learning across states is uneven because it is contingent on the

growth of internal information and knowledge markets, the structured processing of

information and the robust management of human capital. Learning in any state will be as

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[122] For a general overview of the literature on state learning see, Levy, "Learning and Foreign Policy."

[123] Levy, "Learning and Foreign Policy," pp. 286-287.

[124] Checkel, "Why Comply?", pp. 562-564.

[125] Chris Argyris and Donald A. Schon, *Organizational Learning*, (Reading: Addison-Wesley, 1980), pp. 26-28.

[126] Philip E. Tetlock, "In Search of an Elusive Concept," in George W. Breslauer and Philip E. Tetlock eds., *Learning in US and Soviet Foreign Policy*, (Boulder: Westview Press, 1991), p. 22.

[127] Levy, "Learning and Foreign Policy," pp. 287-289.

good as its institutional and organizational capacity to aggregate information and knowledge markets, integrate them with human capital and monitor their performance. However, learning in covertly proliferating states is problematic because it occurs under an institution of severe internal secrecy. The latter is necessary to hide the state's activities from the scrutiny of a hostile nonproliferation regime. However, secrecy is also problematic because it spawns internal opacity and compartmentalizes information. These institutional conditions cocoon decision-makers in a regime of relative ignorance. Unless decision-makers consciously apply themselves to counteract the pernicious effects of this regime of ignorance, learning and socialization practices in the state will be weak and performance lags will remain a recurring phenomenon.

At a base level, the fundamental security challenge that states face in the international system is one of uncertainty. The key resources in the management of uncertainty are information and knowledge. Information *per se* is generally not a problem. The world is awash in it. However, identifying relevant information is usually a challenge. Further, unprocessed information, like raw material, has limited value. Information must be processed into knowledge before it becomes actionable. Therefore, as a first step in managing uncertainty, states mobilize a society's curators of knowledge, its "epistemic community." Epistemic actors are central to interpreting information, crafting a state's response to problem sets, identifying alternatives and educating policy makers on actionable policies. Second, states require structured information processing institutions to enable decision-makers separate signals from noise. This is because research in cognitive psychology shows that individuals in isolated and informal decision-making contexts draw conclusions on the basis of heuristics and biases. The latter distort reality. However, decision-makers can avoid the problem of

cognitive biases and errors by farming out problem solving to multiple epistemic agents and subjecting their output to independent peer review. Finally, states are best able to deal with the challenges of uncertainty when decision-makers have the institutional capacity to monitor the activities of their epistemic and other bureaucratic agents. Successful monitoring in turn is contingent on organizational transparency and an institutional permissiveness that allows various agents to monitor one another. It is also contingent on free flowing information channels that allow information to percolate up the organizational decision-making chain.

More specifically in India's context, I argue that the nuclear policy lags observable across the last three decades, are largely self-imposed. They emanate from the state's weak learning practices. They are the consequence of the absence of a well-mobilized and strongly institutionalized nuclear epistemic community within the state. Policy in the two decades prior to 1998 devolved upon a fragile network of epistemic actors that consisted of a handful of nuclear and defense scientists. Lacking independent institutional power, this actor network was neither able to extract credible commitments from risk-averse decision-makers nor able to impose on them a deductive and well-planned approach to the proliferation project. Decision-makers therefore dealt with the project sequentially leaving gaps in several areas unaddressed. Further, until the beginning of the 21st century there were no structured information processing and knowledge production organizations inside the state to advise decision-makers on nuclear issues in particular and national security in general. For the most part, heuristic methods of judgment were the basis for decision-making. Secrecy also denied the weaponization program a "wisdom of the crowds" scrutiny from multiple actors and agencies within that state. The lack of an independent peer review process left several policy

biases and program lacunae unaddressed. Finally, the severe regime of internal secrecy not only succeeded in denying information about India's covert weaponization efforts to hostile outsiders, but it also created "information asymmetries" within that prevented political principals from successfully monitoring their scientific and bureaucratic agents. Although these theoretical observations are more germane to the covert phase of India's nuclear policy developments, yet, several negative path dependency effects of the above institutional practices have persisted even in the aftermath of 1998 when Indian formally declared itself a nuclear weapons power.

In the rest of this chapter I elaborate the theoretical substance of my arguments in three parts. The first part draws on literatures from sociology and international relations that dwell on the learning and socialization roles epistemic communities play in society. In international relations literature, epistemic communities are typically valorized for their role in diffusing ideas among states, socializing decision-makers into adopting specific policies and coordinating international action. However, my theoretical framework elaborates how institutional practices concerning epistemic actors and traditions are central to the formation of well-developed knowledge markets and corresponding state learning at the domestic level. The second set of arguments tie learning in states to high information turnover, structured information processing and decentralized problem solving. Drawing insights from research in cybernetics and cognitive psychology, I argue that decision-makers operating in isolated organizational settings are vulnerable to heuristic fallacies. For a variety of reasons, the compartmentalization of knowledge and isolated decision-making processes also slows the pace of policy innovation. In the third and final section, I turn to principal-agent problems of "information asymmetries" and "monitoring" in organizations. This model has been

widely used in the study of markets, private firms, governments and a myriad other institutions and organizations. Following this tradition, I use theoretical frames from economics, agency theory, sociology and ethics and apply them to the challenges of management and performance in proliferating states.

The Institutional Role of Epistemic Actors

An "epistemic community" can be imagined as what Ernst Haas's famously described as the "purveyors" of expertise. In Haas's idealized characterization, the epistemic community is the vessel of a society's "consensual knowledge." Consensual knowledge is knowledge generally considered authoritative. It is derived through scientific and non-scientific means. Such knowledge does not transcend ideology or culture. Rather, consensual knowledge is a constructed mix of scientific knowledge and political choices. It differs from ideology to the extent that its internal validity is subject to "truth tests" from rival claimants of intellectual authority.[128]

Members of an epistemic community have a "substantive" or "technical" understanding of cause and effect in so far it pertains to their domain expertise. They have internally agreed upon (formal and informal) methods of testing claims and reaching judgments. They favor analytic means and comprehensive solutions to problem sets. Above all, they are united by the belief that institutionalizing their knowledge through policy will provide effective solutions to the state's identified problems.[129] Epistemic communities are by no means

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[128] Ernst B. Haas, "Organizations: Adapters or Learners?" *When Knowledge Is Power: Three Models of Change in International Organizations,* (Berkeley: University of California Press, 1990), pp. 20-23; Haas, "Collective Learning: Some Theoretical Speculations," pp. 65-66.
[129] Haas, "Collective Learning: Some Theoretical Speculations," pp. 66-69.

"hegemonic." Rather, they care about specific domains that correlate with their areas of expertise; and they try and shape policies in those areas.[130]

What epistemic communities bring to the table are shared views of the social and the physical world, particularly the ties that bind causes to outcomes. For example, strategic nuclear theorists tend to see causal links between the acquisition of nuclear weapons by states and the denial of credible threats of nuclear use. Arms controllers favor arms reductions and politically determined technology restraints as causal means for strategic stability. Experts who study global warming tie the rise in atmospheric temperature and climate change to an increase in the emission of greenhouse gases.

Members of an epistemic community are not restricted to any one particular profession. They tend to transcend professions and are generally an eclectic lot.[131] A community favoring nuclear proliferation for example will likely consist of nuclear scientists, military leaders, strategic analysts, civilian bureaucrats and politicians. Epistemic communities are also different from bureaucracies and interest groups. Bureaucracies are organizations that often favor policy positions out of budgetary or organizational concerns. Similarly, interest groups are also often coalitions of convenience.[132] In contrast, as sociologist Ben David has argued, the glue that binds epistemic coalitions is ethical. It is borne out of inner

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[130] Emanuel Adler & Peter M. Haas, "Conclusion: Epistemic Communities, World Order and the Creation of a Reflective Research Program," *International Organization*, Vol. 46, No. 1 (Winter 1992), p. 371.
[131] Peter M. Haas, "Introduction: Epistemic Communities and International Policy Coordination," *International Organization*, Vol. 46, No. 1 (Winter 1992), p. 3.
[132] Ibid., p. 19.

convictions.[133] In other words, epistemic coalitions hang together by normative and not professional codes.

There are different causal pathways for the formation of epistemic communities within states and the international system. Such communities can grow indigenously within states. For example, the arms control community that emerged in the United States in the 1950s and 1960s grew out of a network of scientists, scholars and policy practitioners from nuclear labs, universities and think tanks.[134] Members of this group wrote, published and played the role of public intellectuals. Their critical dialogue took the form of "truth tests." It helped in the formation of "consensual knowledge," which they shared with US government officials and their Soviet counterparts during the Cold War and which ultimately became institutionalized through arms control agreements between the superpowers.[135]

Alternatively, groups of experts occupying critical positions in government within states can help forge consensus on policy. Thus during World War II and its immediate aftermath, a group of liberal economists and policy planners in the US and Britain helped shape the rules of a liberal world economic order that balanced elements of an open trading system with Keynesian government intervention, control and stability.[136] In another instance, a global epistemic community on food aid emerged out of international organizations and private sector initiatives between 1950-1990. Through international organizations, international

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[133] Ibid. p. 20.
[134] Emanuel Adler, "The Emergence of Cooperation: National Epistemic Communities and the International Evolution of Nuclear Arms Control," *International Organization*, Vol. 46, No. 1 (Winter 1992), pp. 111-116.
[135] Ibid., pp. 124-140.
[136] G. John Ikenberry, "A World Economy Restored: Expert Consensus and the Anglo-American Post-War Settlement," *International Organization,* Vol. 46, No. 1 (Winter 1992), pp. 289-321.

conferences, publications and public criticism, this community reshaped the politics of food aid in the United States from one that in the 1950s lumped humanitarian with domestic agricultural and geopolitical objectives to one that acquired an overwhelmingly humanitarian focus by the 1990s.[137]

It is more likely that a nuclear weapons-centric epistemic community will grow indigenously within a proliferating state, although there may be exceptions to that rule. During the Cold War for example, the US arms control epistemic community helped one grow in the former Soviet Union. Because the majority of the states in the international system oppose nuclear proliferation, foreign governments and international organizations are unlikely to play the role of socializers. Furthermore, the nonproliferation regime, despite all its inherent contradictions, has gained legitimacy over time.[138] If anything, states and international organizations will be more likely to diffuse norms and ideas to freeze and rollback proliferation. Within the proliferating state, therefore, an epistemic community will in theory emerge from the scientific community involved in developing and testing weapons. It will draw from the strategic and international relations community in think tanks and universities grappling with the challenges, trade-offs and consequences of nuclear weapons acquisition. And ultimately, it will have representatives from the military on whom the doctrinal and operational challenges of the nuclear arsenal will ultimately devolve. It is also likely that some public intellectuals, bureaucrats and politicians could become part of the nuclear epistemic community. For the most part, however, the group's core membership will consist of experts from the fields of nuclear weapons design, strategy and use.

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[137] Raymond F. Hopkins, "Reform in the International Food Aid Regime: The Role of Consensual Knowledge," *International Organization,* Vol. 46, No. 1 (Winter 1992), pp. 225-264.
[138] See for example, Maria Rost Rublee, *Nonproliferation Norms: Why States Choose Nuclear Restraint*, (Athens: University of Georgia Press, 2009).

In one sense, the nuclear epistemic community in clandestinely proliferating states will never be a true scientific community that exists outside the state; of the type conceived in sociological and international relations literature.[139] This is because such a community cannot exist independently outside government. Further, in light of the secrecy surrounding the nuclear weapons program, the relative paucity of information and political sensitivities surrounding public discussion of the program, a robust form of "consensual knowledge" will be hard to form. Thus the nuclear epistemic community in a proliferating state can be re-conceived as a "primitive" group[140] consisting of professionals and policy specialists within and outside government who share a common normative understanding of nuclear deterrence. But exist it must in some institutional form within and outside the state. And transmit it must its expertise to key policy planners and decision-makers to give coherent direction to the proliferation effort.

The linkages between expertise, learning and policy outcomes are what make modern states modern. As Harvey Brooks puts it, "much of the history of social progress in the 20th century can be described in terms of the transfer of wider and wider areas of public policies from politics to expertise." This does not of course mean that politics is absent from the process of policy making. All policy is ultimately political. However, episteme gives essence to policy by defining its content, scope and more significantly by providing the alternatives to the status quo. The role of epistemic communities in this regard is to push the envelope of research and intellectual innovation, a process necessary to grow society's knowledge

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[139] Haas, "Epistemic Communities and International Policy Coordination," pp. 16-20.
[140] I borrow this characterization from John Ikenberry, See, Ikenberry, "A World Economy Restored: Expert Consensus and the Anglo-American Post-War Settlement," p. 293.

banks and provide decision-makers with optimized solutions to problems. In a sense, therefore, the condition of a society's existing epistemic community is a broad measure of its intellectual frontiers in a specific domain at a given time.

But the existence of an epistemic community in and by itself is a necessary but insufficient condition for policy learning within a state. For learning to happen, decision-makers must take the crucial step of mobilizing the society's epistemic community. However, decision-makers will have incentives to undertake such a measure only when they commit the state to achieving a set of "expanded" and "interconnected" as against "limited" and "static" goals.[141] An expanded and interconnected set of goals in the context of nuclear proliferation for example would be the commitment to fissile material production, weapon development, testing, weaponization, and operational planning as part of a program that has an organic texture. The example of limited and static goals on the other hand would involve halting steps along each rung of the proliferation ladder over an extended time period. Leaders need professional expertise when goals are complex; when they are expansive and tightly coupled. But decision-makers are less likely to demand the sustained intellectual attention of an epistemic community when goals are limited, static or loosely coupled.[142]

The degree of policy innovation in a proliferating state will therefore depend on whether decision-makers decide in favor or against mobilizing its nuclear epistemic community. This is because experts apply analytic methods to think through problem and solution sets. They carry the intellectual and emotional commitment to apply the cumulative knowledge of their domain expertise to a society's problems. They use holistic approaches to resolve the

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[141] Haas, "Collective Learning: Some Theoretical Speculations," pp. 66-69.
[142] Ibid.

problem of misaligned means and ends. Instead of incremental advances they generally show

a preference for strategic approaches, which fundamentally rethink solutions to problems.[143]

In comparison to domain specialists, political leaders generally lack expertise and tackle

problems piecemeal. Not only that. They have short attention spans and even shorter time

horizons. Epistemic communities, therefore bring together policy innovators and executors.

They play, in John Ruggie's characterization, the role of "switchboards." To be sure, Ruggie

and other international relations scholars have largely focused on the role epistemic

communities play in inter-state socialization and coordination functions. However, such

communities play an equally significant role in educating decision-makers domestically.

Mobilization apart, the strength of an epistemic community's institutionalization within a

state will determine that state's speed of learning and policy innovations. Institutionalization

can be stated very simply as the "development of new organs, principles of action, and

administrative practices…designed to improve the performance of the polity…"[144] Learning

within the state will be most effective when epistemic actors are able to inject new

consensual knowledge and institutionalize it into the state's habitual routines. In this regard,

three measures are useful for assessing an epistemic community's institutional strength

within a state.

The first is the community's longevity. By this I mean, its continuous existence across

successive leaders and governments. Expert communities that are institutionalized within the

state are able to accumulate information and grow their expertise. Such gains in knowledge

expand their institutional authority inside and outside the state over time. They become the

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[143] Ibid., pp. 69-84.
[144] Ibid., p. 89.

sources of authoritative knowledge. In this capacity, they also serve as policy transmission belts and coordination agents for decision-makers. Hence, entrenched epistemic authorities will be in a strong position to educate decision-makers and the state by extension.

Second, epistemic actors should also have some access to sensitive information. Douglas North illustrates this point by showing how rapid information turnover in the marketplace is crucial for firms' learning and survival.[145] In the policymaking world similarly, data availability facilitates the task that epistemic actors do best: judgment formation and idea contestation to prepare better policies to deal with political challenges. Curtailed information flows on the other hand prevent epistemic actors from performing these tasks and in the process from identifying policy flaws and lags. They also become an institutional barrier for coordinating action among them.

Information is a critical resource for another reason. Unlike well-functioning markets where alternative ideas and institutions often co-exist, political markets embody a "winner takes all" approach.[146] This is especially true in national security idea markets where the relative scarcity of information and high costs make political decisions sticky. Initial decisions impose strong adaptive effects on other actors and in the process reinforce their own stability. Hence it is vital for epistemic communities to be able to shape the status quo before it becomes self-reinforcing. Further, in the absence of information, epistemic actors will be unable to generate credible alternatives to the status quo in the absence of supporting information.

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[145] Douglas C. North, *Institutions, Institutional Change and Economic Performance,* (Cambridge: Cambridge University Press, 1990), pp. 46-60.
[146] Paul Pierson, "Increasing Returns, Path Dependency and the Study of Politics," *American Political Science Review,* Vol. 94, No. 2 (June 2000), pp. 257-262.

Third and finally, the institutional and continuous presence of an epistemic community within government is a necessary but insufficient condition for state learning. For learning to occur, the epistemic actors must possess some means to extract commitments for specific policy actions from decision makers.[147] Decision-makers usually signal commitments to specific policies through political, institutional and budgetary means. These latter actions bind the agency of decision-makers for the long term because deviations from commitments are measurable. They generate internal audience costs and have the potential to hurt the reputation of shirking decision-makers. In effect, commitments become a form of a "time lengthening" mechanism, which signals to epistemic actors that political actors are bound to a policy for the long term.[148] Such mechanisms have the benefit of two functions. They provide epistemic actors the institutional means to monitor the performance of decision-makers. They can do this by inflicting reputation losses on the shirking decision-maker. Equally significant, on a personal psychological level, they serve as morale boosters for epistemic actors because their motivations are primarily professional and ethical. Political assurances of credibility help them follow the strength of their intellectual and emotional commitments through.

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[147] Paul Pierson, "The Limits of Change: Explaining Institutional Origin and Change," *Governance: An International Journal of Policy and Administration,* Vol. 13, No. 4, (October 2000), pp. 475-499.
[148] Ibid.

Table 2

Epistemic Actors & State Learning

Condition	Impact
• Sustained institutional presence	• Sources of authoritative knowledge within government • Transmission belts for ideas • Coordination agents for decision-makers
• High information turnover • Access to sensitive information	• Judgment formation • Idea contestation • Credible alternatives to status quo
• Ability to extract political, institutional & budgetary commitments from decision-makers	• Bind agency of decision-makers • Monitor performance of decision-makers • Sustain emotional commitments to policy

Monopolist Decision Making, Psychological Biases and Organizational Learning

Structural theories also generally assume that nuclear decision makers in emerging nuclear powers are rational choice agents. The belief is that nuclear aspirants in the international system seek to maximize strategic gains. These theories further assume that rational choices are possible because the nuclear decision-making process in proliferating states is secret,

selective and isolated. The latter conditions prevent the rationality of decisions from being

contaminated by the hurly burly of domestic and organizational bureaucratic politics.[149]

Without doubt, the assumptions of secrecy and isolated decision-making are true. However,

the related surmise that a highly select and relatively unitary or monopolistic decision-making

process renders decisions optimal is highly problematic.

The weight of evidence from experiments in the fields of Cybernetics and Cognitive

Psychology as well as examples from the real world show that rational optimization is an

abstract myth removed from reality. Decision-makers do not always have a well-defined set

of utility functions. Nor do they systematically proceed down deductive decision trees

making value and utility choices. More often, they lack the capacity to analyze in one sweep

the entire range of choices before them. Nor do they fully anticipate the consequences of

their choices. The decisions they make are often sequential, not comprehensive.[150] Issue

frames and the order of choice critically shape decisions. Equally significant, strong internally

held biases compete with reason in the making of judgment calls. Decision-makers, to use

Herbert Simon's famous characterization, are "boundedly rational."[151]

Indeed, behavioral insights from cybernetics and cognitive psychology offer a more realistic

approach to understanding decision-making under monopolistic and secrecy institutions,

which are the conditions one is likely to find in post-NPT proliferating states. In

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[149] Vipin Narang, *Posturing for Peace? The Sources and Deterrence Consequences of Regional Power Nuclear Postures*, PhD Dissertation, (Cambridge: Harvard University, April 2010), pp. 143-144.
[150] Charles Lindblom, "The Science of Muddling Through," *Public & Administration Review,* Vol. 19, No. 2, (Spring 1959), pp. 79-88; "Still Muddling, Not Yet Through, *Public Administration Review,* Vol. 39, No. 6, (Nov-Dec 1979), pp. 517-526.
[151] Simon, "Alternative Visions of Rationality," pp. 19-23.

Streinbruner's cybernetic model, decision-makers' primary motivation is uncertainty control and the retention of simplicity and consistency of their belief systems.[152] They achieve this by what Herbert Simon described as the "process decision of reality."[153] The latter is less like a constructed blueprint of reality and more like a recipe. Decision-makers typically follow a set of instructions sequentially, produce an outcome without fully understanding its implications and then await environmental feedback to appraise the quality of their decision before making further adjustments.[154] Because environments are complex there is always tension between decision-makers' need for control and the demands of adaptation in a complex environment. Decision-makers therefore have the choice of resolving this tension in two ways: first, they can maintain internal simplicity by screening out information and only accepting information through highly selective feedback loops. Second, they can decompose problem sets and assign fragmented bits to multiple individuals and organizations to resolve.[155]

If decision-makers choose to screen out information, chances are that optimization will be minimal. But even if they decide to parcel out problem sets to individuals and organizations, the issue of solutions aggregation will be a challenge. This is because in monopolist or highly centralized decision-making structures, problems can only be resolved sequentially; in the manner in which they are raised. Hence the problem of aggregation will be a critical roadblock to optimization. Decision-makers will tend to monitor feedback loops and discover the effects of their actions as they register feedback. If problems persist, then decision-makers can go down the path of "problemistic" search and scan the environment

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[152] Steinbruner, "The Cybernetic Paradigm," *The Cybernetic Theory of Decision,* p. 66.
[153] Ibid., pp. 54-55.
[154] Ibid.
[155] Ibid., pp. 66-69.

for solutions.[156] But in a restricted and secret environment, such as the one encountered by proliferating states, they will generally turn to trusted sources and selective mechanisms already available at hand. It is also likely that during interaction of the decomposed problems' components decision-makers will leave many of the optimization trade-offs unresolved. As a consequence, the system will evolve slowly evoking what Charles Lindblom characterized as the process of "muddling through."[157]

However, the cybernetic model has two limitations. First, it does not address decision-making under conditions of great complexity and uncertainty. And second, it does not deal with the role values play in judgment formation. Here, cognitive psychology helps us further. Its fundamental insight is that individuals simplify highly complex and ambiguous environments by imposing their internally held belief systems on it to give it structure and make it legible. Their goal remains the same as before: economy, i.e., bringing "simplicity" and "stability" to their decision-making.[158] Most individuals achieve this goal though what Herbert Simon termed as "satisficing" and not optimizing as rational choice theorists would have us believe.[159] In other words, most individuals reach decisions once some internally held values and aspirations are satisfied. Research also shows that individuals tend not to make value trade offs under conditions of uncertainty, as rational choice theorists would expect.[160] Rather, they do that only when compelled under the force of an external shock.

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[156] Ibid., pp. 71-85.

[157] Lindblom, "The Science of Muddling Through."

[158] Steinbruner, "Cognitive Processes," *The Cybernetic Theory of Decision*, pp. 90, 109-112.

[159] Simon, "Rational Processes," *Reason in Human Affairs,* p. 85.

[160] Steinbruner, "Cognitive Processes," pp. 112-121.

Research in the field of cognitive psychology also demonstrates that decision-makers generally use analogies, wishful thinking, the notion of impossibility, social reinforcement and "group think" to manage uncertainty, which is essentially the gap between the environment as it actually is and their knowledge of it.[161] In the 1970s and 1980s, Kahneman and Tversky's 'heuristics and biases' program and the experimental data it generated compellingly demonstrated that individuals reach decisions through the use of heuristics or "simple rules of the thumb."[162] Two heuristics in particular, the 'representative'[163] and the 'availability' heuristic,[164] explain decision-making more realistically than any rational choice model. Both heuristics are anchoring phenomena, which operate on the principle of analogies. Experiments show that people reach conclusions about events and people not on the statistical probability of an event happening or the population size, but simply on the basis of how one event or individual is intuitively perceived as representative of another or on how vividly they can recall a similar situation or context from their memories. In Gilovich and Griffin's words, the heuristics that most individuals use yield "serviceable solutions" to "compelling problems." But that which is serviceable is not necessarily optimal.[165]

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[161] Ibid.

[162] Daniel Kahneman, Paul Slovic, and Amos Tversky, *Judgment Under Uncertainty: Heuristics and Biases,* (Cambridge: Cambridge University Press, 1982).

[163] Daniel Kahneman and Shane Frederick, "Representativeness Revisited: Attribute Substitution in Intuitive Judgment," in Thomas Gilovich, Dale Griffin and Daniel Kahneman eds., *Heuristics and Biases: The Psychology of Intuitive Judgment,* (Cambridge: Cambridge University Press, 2002), pp. 49-81.

[164] Norbert Schwarz and Leigh Ann Vaughn, "The Availability Heuristic Revisited," Ease of Recall and Content of Recall as Distinct Sources of Information," in Gilovich, Griffin, and Kahneman eds., *Heuristics and Biases,* pp. 103-119.

[165] Gilovich and Griffin, "Introduction – Heuristics and Biases: Then and Now," in Gilovich, Griffin and Kahneman eds., *Heuristics and Biases,* p. 4.

To be sure, even when individuals do not deploy formal optimization models, their decisions can be intuitively rational. But this line of reasoning is more germane to specialists who acquire expertise over years of training and experiential knowledge. Chess grand masters for example can often take in an entire game with a swift glance. But most political decision-makers are not experts in nuclear arcana. There is also a hidden problem with expertise itself. Most experts also zero in on problems through the use of heuristics.[166] In other words, the experts problem solve on the basis of what they already know; what is strongly etched into their memory already; and what they can easily recall. Unless specifically tasked, even experts typically do not optimize.

The one method that enables individual decision-makers transcend individual cognitive limits is parallel processing, the parceling out of analysis and decision-making to specialist organizations. One of the central insights of the Carnegie School was that organizations help solve problems of individual cognitive limits that limit organizational optimization.[167] After all, it was Weber who successfully argued that organizations embody rational choice. Simon and March subsequently made the point that unlike individuals who have limited attention spans and can only focus on one problem at a time, organizational parallel processing permits problem decomposition.[168] Although second generation organizational theorists in the 1960s such as Allison popularized the view that organizations were *the* problem due to their standard operating procedures (SOP) and hidebound practices,[169] a less conventional

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[166] Jonathan Bendor, "Herbert A. Simon," *Bounded Rationality and Politics,* (Berkeley: University of California Press, 2010), p. 42.

[167] Bendor, "Institutions and Individuals," *Bounded Rationality and Politics,* pp. 164-165.

[168] Ibid.

[169] For a critique of Graham T. Allison's rational actor model see, Jonathan Bendor and Thomas H. Hammond, "Rethinking Allison's Models, *The American Political Science Review,* Vol. 86, No. 2, (June 1992), pp. 301-322.

view propounded by Landau and Wildavsky is that policy innovation occurs when organizations compete over it.[170]

Parallel processing and the decomposition of problems across organizations enable optimization in four ways. First, decisions become based less on folk heuristics and more on scientific processes. Second, the pooling of expertise creates room for the cross fertilization of ideas. Third, just as good hardware engineering involves building redundancies into technological systems to guard against sub-system and individual component failures, redundancies in the decision-making create an ecosystem for the co-existence of alternative logics that can compensate for the failure of any single dominant approach.[171] Finally, distributed decision-making serves as an institutional check against what Janis identified as "groupthink," the tendency among closed groups of decision makers to favor group harmony and consensus over critical evaluation of alternative points of view.[172] Thus monopolist decision-making concentrated in a few decision-makers leads to a closed political system and retards the process of structured optimization.

Weak Information Markets and the 'Principal-Agent' Problem in Proliferating States

Finally, positive learning and policy growth in a proliferating state will substantially depend on how well political principals manage their epistemic and other bureaucratic agents tasked with executing the weapons development and its ancillary programs. In a proliferating state, the principals can be imagined as the key decision-makers in the political executive and their

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[170] Bendor, "Institutions and Individuals," p. 171.

[171] Ibid., pp. 165-172; also see, Jonathan B. Bendor, "The Theory of Bureaucratic Competition and Redundancy," *Parallel Systems: Redundancy in Government,* (Berkeley: University of California Press, 1985), pp. 24-60.

[172] Irving L. Janis, "Symptoms of Groupthink," *Groupthink: Psychological Studies of Political Decisions and Fiascoes,* (Boston: Wadsworth, 1982), pp. 174-175.

agents the scientists, the engineers, the bureaucrats, the strategic theorists and the military.

The principal-agent problem afflicts all organizations. However, regimes of information

scarcity can exacerbate the dilemmas of effective organizational control and management for

principals.

In any principal-agent relationship individuals in an organizational hierarchy (principals)

assign and contract others down the chain (agents) to do tasks for them. The problem in this

relationship arises from two factors. First, the interests of the principals and their agents do

not always precisely overlap. And second, the agents are generally the experts in this

interaction. This latter creates conditions of "information asymmetry" that often allow the

agents to control their principals. Goal divergence and information asymmetry are

problematic in any principal-agent relationship because the act of risk taking and the

responsibility for that risk are bifurcated. The agents take most of the risk, but their

principals bear most of the responsibility for that risk.[173]

What this means for situations where the interests of the principals and their agents do not

fully coincide is that the latter can take actions that have the potential of undermining the

principals' interests. One manifestation of this problem is "moral hazard" where due to

conditions of information asymmetry the principals may be unable to fully monitor the

actions of their agents.[174] Another manifestation is "adverse selection" where the principals

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[173] Oyvind Bohren, "The Agent's Ethics in the Principal-Agent Model," *Journal of Business Ethics,* Vol. 17, No. 7 (May 1998), pp. 746-748. For an overview of the application of the principal-agent theory to the discipline of political science in general see, Gary J. Miller, "The Political Evolution of Principal-Agent Models," *Annual Review of Political Science,* Vol. 8 (2005), pp. 203-225.
[174] Paul Milogram and John Roberts, "Moral Hazard and Performance Incentives," *Economics, Organization and Management,* (Prentice Hall, 1992), pp. 166-167.

might commit to actions their agents recommend without fully understanding the risky consequences of those actions.[175] The net effect of both moral hazard and adverse selection is harm to the principals' interests.

The most popular application of the principal-agent model is the business firm where the interests of the shareholders and professional managers who run operations are often at odds with one other. Other successful applications of the model include small partnerships, non-profits, charities, schools and governments.[176] When applied to business firms, the assumption is that property relations create natural incentives for agents to "shirk;" unless, of course, the principals devise robust incentive and monitoring mechanisms to control them. More generally, however, sociologists and ethicists contest the model's applicability to the public sector when it does not involve property relations and the maximization of profit.

Charles Perrow for example is deeply skeptical of the principal-agent model because it goes against the grain of social cooperation.[177] Similarly "stakeholder" theorists such as Neil Shankman reject the unethical and depraved view of human nature and point to ethical commitments as the basis of cooperation.[178] This is not to deny that principal-agent problems do not exist in the public sector. However, the goal of agents in the public sector

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[175] Milogram and Roberts, "Bounded Rationality and Private Information," *Economics, Organization and Management,* pp. 149-150.

[176] Eugene F. Fama & Michael C. Jensen, "Separation of Ownership and Control," *Journal of Law and Economics,* Vol. 26, No. 2, (June 1983), pp. 301-325. For an expanded version of the principal-agent model see, Richard W. Waterman & Kenneth J. Meier, "Principal-Agent Models: An Expansion?" *Journal of Public Administration Research and Theory: J-PART,* Vol. 8, No. 2, (April 1998), pp. 173-202.

[177] Charles Perrow, "Agency Theory," *Complex Organizations: A Critical Essay*, (New York: McGraw Hill, 1986), pp. 224-235.

[178] Neil A. Shankman, "Reframing the Debate Between Agency and Stakeholder Theories of the Firm," *Journal of Business Ethics,* Vol. 19 (1999), pp. 319-334.

is more often the generation of public goods. In one sense, the building of nuclear weapons is the ultimate public good as it enhances a polity's national security and prestige. Hence a safe assumption can be made that agents tasked with proliferation activities will possess a high professional and mission drive.

That said, there will always be "knights" and "knaves" among agents even in the public sector. Further, individual agents themselves will combine qualities of both in some mix. Knights, according to Le Grand, are agents driven by professional and altruistic concerns and strive to promote the interests of their principals. The knaves on the other hand tend to be selfish and opportunistic.[179] What all this means in a proliferating state is that the principals' agents will to a large extent share a high nationalistic, professional and emotional commitment to proliferation. Their ethical norms to a degree will ease some of the tensions assumed in the more pessimistic business model. Nonetheless, there is also the likelihood that the interests of principals and the agents will not precisely overlap.

The reason for this is that political principals' represent a broad array of national interests. Even as they pursue proliferation goals, they will want to balance those goals with other competing domestic and foreign policy interests. In contrast, their agents who represent the nuclear labs, the military-industrial complex and the armed services more generally, will exhibit a narrower set of professional and organizational goals. The latter will share an innate propensity to pursue their narrower professional goals disproportionately. As a consequence, the principals will nearly always retain some wariness toward their agents, because they

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[179] Cited in Rosalind Levacic, "Teacher Incentive and Performance: An Application of Principal-Agent Theory," *Oxford Development Studies,* Vol. 37, No. 1 (March 2009), p. 35.

disproportionately shoulder the residual risks of proliferation under a hostile nonproliferation regime.

The act of nuclear acquisition by any non-nuclear state is a dangerous enterprise because of the constant threat of prosecution by the international nonproliferation regime. Hence principals in a proliferating state will have incentives to maintain a severe regime of internal secrecy to hide the program's existence. There are however domestic reasons for secrecy as well. The principals will fear that their agents might force their hand prematurely through information leaks. This fear of loss of agenda control will constitute a secondary incentive to treat the weapon development effort as a black program. The only way principals can avoid ceding agenda control to their agents is by compartmentalizing the proliferation program within an agency executing it. If parts of the program such as fissile material production, weapon design, carriage and operational planning are distributed across multiple agents and agencies, the principles will attempt to retain agenda control by blocking or limiting inter-agent and inter-agency information exchange.

However, the twin processes of secrecy and compartmentalization also create a perverse problem for the principals in managing their agents. As the principal-agent theory informs us, agents enjoy the power of information asymmetry. Principals usually find the costs of policing their agents to be very high due to cognitive problems of "bounded rationality" as well as their agents' domain expertise. Furthermore, the agents constitute the permanent state. They are usually the best informed about how bureaucratic processes work within their specific agency and the state in general. In these circumstances, the best methods available to

principals for monitoring their agents' actions are transparency and information availability. However, the latter conditions directly contradict the primary demand for secrecy.

In most organizations, there are three methods available to principals to reduce the cost of monitoring their agents. The first is transparency and easy information availability. This process renders the agents' actions easily visible to the principals. The second is competition among multiple agents. This process allows agents to monitor one another and also act as checks on each other. Further, mutual monitoring among agents is a relatively easy way for information to percolate up the organizational chain to the principals. Finally, principals' use institutionalized boards of independent experts (epistemic communities) to level information asymmetries between them and their agents in two ways. In the first, the boards vet actions at the initiation or project specification stage. In the second, they verify if the outcomes are in line with the bargains that agents struck with the principals at the specification stage.[180] If projects stall or fail, the boards then independently verify if the outcomes are the consequence of agents' shirking or due to random events outside their control.

However, the covert nature of most weapon programs makes the institution of transparency, information availability and multiple agent competition difficult. To be sure, even in imperfectly functioning information markets principals have screening devices[181] to ensure baseline quality. Just as education and schools serve as screening devices for employers to certify the credibility of potential employees amid uncertainty, the state's bureaucratic organizations, especially its scientific and technical organizations, have internal mechanisms

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[180] Fama & Jensen, "Separation of Ownership And Control," pp. 310-311.

[181] Joseph E. Stiglitz, "The Theory of Screening: Education and the Distribution of Income," *The American Economic Review,* Vol. 65, No. 3 (June 1975), pp. 283-300.

to ensure quality control. Agents too can use signaling devices,[182] such as technical benchmarks and breakthroughs, thresholds and actual tests of the weapon systems to help principals bridge the information gap.

However, the screening and signaling devices that work in the education and employment markets for example, don't work with analogous efficiency in the proliferation market. Nuclear proliferation falls in the category of large technological projects. Such projects are huge organizational efforts with vastly extended time lines. In such hugely complex projects, it is difficult for principals to distinguish if agent successes and failures are due to shirking or random effects. Secrecy concerns also prevent covertly proliferating states from conducting full-scale weapon tests, thereby limiting the signaling capacity of agents. Further, unless institutionalized epistemic bodies can undertake independent peer review, the principals will find it hard to filter out signals from the background noise. In markets, product successes and failures are the ultimate benchmark to verify the fidelity of agents' signals. However, the likelihood that weapons of mass destruction will ever be used in battle is exceptionally low, thus leaving the value of agents' signaling in the absence of a rigorous program of field tests and independent peer review moot.

Expectations of Secrecy's Rationality-Bending Effects Model

In contrast to structural theories, which assume that states respond rationally and optimally to visceral national security threats, I argue that secrecy generates distortionary effects, which stymies the process of rational decision-making. In my framework, the nonproliferation

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[182] For an overview of agents' use of signaling devices see, Michael Spence, "Job Market Signaling," *The Quarterly Journal of Economics*, Vol. 87, No. 3 (August 1973), pp. 355-374; also see, Milogram and Roberts, "Bounded Rationality and Private Information," pp. 154-155.

regime forces nuclear proliferation in post-NPT nuclear wannabe states underground. The process of covert proliferation hobbles nuclear learning because state leaders operate under a self-induced regime of ignorance. This ignorance has institutional, organizational and cognitive roots and its negative effects operate in three ways.

First, in every state, epistemic communities are central to the process of policy innovation and organizational learning. Epistemic actors play a critical role in forming consensual knowledge about problems and solution sets. They are also the key mechanism for transmitting that knowledge to policy makers, in helping them frame policy choices and in coordinating policy implementation across the state. Policy innovation occurs when states institutionalize new ideas generated by epistemic communities into their habitual routines. However, I expect that decision-makers in clandestinely proliferating states will likely choose goals that are static and loosely coupled. Because such goals do not demand the sustained attention of an epistemic community, the latter will remain an under utilized resource within the state.

Since nuclear proliferation is an activity fraught with high-risk, political decision-makers will also prefer autonomy and flexibility in the decision-making process. I therefore expect that decision-makers will have incentives against institutionalizing epistemic communities strongly within the state. This is because strong institutions carry the risk of increasing decision makers' domestic audience costs and binding their agency. Weak institutions on the other hand protect their reputation and autonomy. However, weak institutions also have the net effect of attenuating the state's policy capacity and reducing its scope for policy innovation. Further, because prevailing institutions create path dependencies, I expect the

negative effects of secrecy to persist and create a drag on learning even after decision-makers openly commit themselves to proliferation policy goals.

Second, state learning is contingent on high information turnover, problem decomposition, distributed decision-making and independent peer review. Information abundance and structured processing of that information within states, or for that matter in any organization, reduce the scope for heuristics and biases in decision-making. However, I expect that decision-makers' in proliferating states will favor weakly developed information and corresponding knowledge markets. They will prefer to hoard knowledge concerning the nuclear weapons program, curtail information flows within the state and centralize decision-making. I expect the net effect of such administrative behavior to be uncorrected cognitive biases among decision-makers and poorly optimized policy decisions.

Third and finally, political leaders need well-developed information markets within the state to monitor agents who they task with proliferation projects. However, the process of covert proliferation fragments knowledge inside the state and diffuses it among various agents. Internal secrecy makes it extraordinarily hard for the decision-makers to accurately monitor and appraise the activities of their agents. Weakly developed information markets also raise the transfer costs of knowledge among the agents themselves. I therefore expect that political leaders, even in highly centralized settings, will lack the means to monitor their agents and the nuclear program's progress effectively. It is also likely that lacunae in programs will go undetected.

Expectations of Standard Structural Theories

In contrast, standard structural theories of international relations presume that proliferation decisions are primarily driven by raison d'Etat. As such their unfolding within the state will follow the path of supreme rationality. Due to the growing legal obstacles and moral norms against the acquisition of nuclear arms, the program will no doubt deviate from standard armament development projects. The project will likely grow within a walled-off secret enclave within the state. The epistemic actors mobilized to enact it will be highly select. However, the actors will draw from a diverse set, which includes nuclear scientists and engineers, military specialists, bureaucrats and political decision-makers. The epistemic actors will enjoy close proximity and access to decision-makers. The latter will tend to proceed with caution given the international opprobrium their actions if discovered are likely to provoke. Nonetheless, given the state's national security concerns and decision-makers commitment to securing them, epistemic actors will enjoy considerable freedom of action, both in terms of access to information and material resources, to bring the nuclear weapons program to fruition. Epistemic actors will also likely find it relatively easy to secure decision-makers' commitments to program choices.

A related assumption made is that the sequestered nature of decision-making within the enclave will not affect its quality negatively. Structural theorists assume instead that cocooned decision-makers make more rational choices when removed from bureaucratic infighting and political compromises that afflict most program choices. Within the state's sequestered enclave, segments of the state's scientific, engineering and military agencies will find the freedom to exchange information freely and cooperate to execute different but related elements of the project simultaneously. Thus fissile material production, bomb design

and delivery systems will all be parts of a boutique but highly coordinated effort. Further, as with conventional weapons, the nuclear hardware once developed will be subject to soft routines such as institutional oversight, strategic principles governing use, intra- and inter-agency coordination. No doubt, secrecy and sequestering will render the weapons special and remove them from the standard administrative processes of the state. The latter institutional conditions however will not immobilize those processes altogether.

Finally, structural theories do not expect that secrecy, reduced information inflows and the relative absence of agent competition are detrimental to efficiency. The unstated assumption is that highly centralized and coordinated state settings will enable political principals to exercise control over their agents with relative ease. High classification and internal opacity are not tantamount to the absence of oversight mechanisms in the state. Just that the state's normal administrative apparatus is unlikely to perform those functions. Given the significance of nuclear weapons, the power likely to accrue to leaders and the state from possessing them, political principals' will seek to retain tight scrutiny over the program's direction and progress.

Table 2.1

	Secrecy-Induced Rationality Bending Effects	Standard Structural Theories
Epistemic Community's Mobilization	• Partial • Sequential	• Highly Select • Diverse
Decision-Making Process	• Informal • Based on Heuristics & Biases	• Formal • Highly Rational & Optimized
Agent Monitoring	• Weak • Problematic	• Strong • Unproblematic

Secrecy and Indian Nuclear Decision-Making

In the next three chapters, I examine Indian nuclear decision-making across three decades, beginning in the early 1980s until 2010. In the first two decades, 1980-1998 Indian nuclear decision-makers operated under a regime of severe internal opacity. Thereafter, the Indian government ended its policy of opacity, both internal and external, and made overt claims to nuclear power status. Between 1980 and 1989, successive Indian governments responded to

an emerging nuclear threat from Pakistan by initiating a nuclear research and development program. From 1989 onward, the Indian government embarked on a course of weaponization and integrating weapon systems with delivery systems. Following nuclear tests in 1998, Indian decision-makers made an internal determination to deploy a nuclear triad with the organizational and institutional means to render the force operational.

If structural theories were an accurate barometer of states' internal response to external pressure, then Indian decision-makers would behave rationally. They would seek to mobilize a diverse but select epistemic community, institutionalize that community, establish walled-off but structured process of decision-making and institute oversight mechanisms to monitor the nuclear weaponization program's progress. The development of the weapon, the preparation of delivery systems and thinking on use principles would proceed simultaneously. There would exist restrictions on information sharing and communications within the secret enclave tasked with the program. But those restrictions would likely not severely constrict the flow of critical information. Decision-makers would have accurate assessments of the state of program's progress within and the potential impact of adversaries' actions without. Once the regime of secrecy ended, rational state actors would exploit the relative freedom rapidly to develop both hardware and the soft organizational and institutional routines to make the arsenal operationally responsive.

On the other hand, if my framework were accurate, the regime of secrecy would distort the ability of Indian decision-makers to achieve optimal outcomes. The epistemic actors mobilized would lack diversity and would remain weakly institutionalized within the state. Information sharing within the secret enclave tasked with weapon development would be

highly restricted such that internal opacity would rival the state's external opacity. The decision-making process would remain informal and ad-hoc. Decision-makers would tend to proceed sequentially with parts of the program in a disjointed manner and gaps in capabilities would remain unaddressed due to their unawareness or non-optimized decision-making processes. In theory, the political principals would exercise supreme control over their scientific and bureaucratic agents. But in practice, information asymmetries exacerbated by sluggish information flows due to secrecy would render their control nominal. Once the regime of opacity ended in 1998 the decision-making process would return to a relatively rational and optimal state, just as structural theories predict. Nonetheless, according to my theoretical framework, the path dependency effects engendered by two decades of institutional practices would create drag in the optimization process.

CHAPTER THREE

THE DISAGGREGATED NUCLEAR OPTION (1980-1989)

Introduction

In May 1974 India exploded a nuclear device and dubbed it a peaceful nuclear explosion

(PNE). But in its wake, India did not declare itself a nuclear weapon state. Nor did it seek

such legal recognition internationally. Bucking the trend of other nuclear weapon powers

until then, and somewhat paradoxically, India did not follow up this lone test with other

tests. Neither did it seek to incorporate nuclear explosives into its military planning. Indian

government representatives publicly insisted that the PNE was modeled after the US

Ploughshares program,[183] which was an experimental attempt to leverage nuclear explosives

in support of large engineering projects. These claims were plausible. However, they were

never backed up any Indian follow-up to use nuclear explosives for civil engineering

programs. To policy practitioners schooled in *realpolitik* who thought the nomenclature of

PNE a political cover for a weapons program,[184] there was also no accompanying evidence

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[183] Project Ploughshares was an experimental program launched by the United States in the 1960s to leverage the use of nuclear explosives in large civil engineering programs. The US Atomic Energy Commission also explored the idea of conducting PNEs in India to quell its quest for prestige and use nuclear excavation to resolve "some of its basic river problems." However, the program was unsuccessful in the United States because of the negative environmental fallout and public opposition. It was finally terminated in 1977. For an overview of the program, see Scott Kaufman, *Project Ploughshare: The Peaceful Use of Nuclear Explosives In Cold War America* (Ithaca: Cornell University Press, 2013); Perkovich, "The Search for Help Abroad," *India's Nuclear Bomb*, p. 91.

[184] In the wake of the 1974 test, Indian Prime Minister Indira Gandhi wrote her Pakistani counterpart Zulfikar Ali Bhutto: "we [India] remain fully committed to our traditional policy of developing nuclear energy for peaceful purposes." To which Bhutto replied that there was no technical distinction between a nuclear explosion for peaceful or military purposes. See, A. Appadorai and M. S. Rajan, "Developments Since 1972," *India's Foreign Policy and Relations*, (New Delhi: South Asian Publishers, 1985), pp. 578-579.

in the form of delivery systems, command control or organizational changes in the Indian military that would signify India's quest for an operational nuclear capability.[185]

India's lone nuclear test spawned the security legend that it was not motivated by national security concerns.[186] However, the very likely answer to the riddle of India's lone 1974 test was the manageable risk of Chinese nuclear blackmail in the short-term due,[187] India's resource constraints, the lack of a diversified industrial infrastructure[188] and Western nonproliferation pressures.[189] By the late 1970s, the balance of threat in the region began to change for the worse as clear indicators emerged of Pakistan's nuclear quest. In the case of Pakistan, the Himalayas did not present a geographic barrier as they did in the north vis-à-vis China. India's struggle against Pakistan was also an ideological and existential one. Pakistan's revanchism became evident after India helped catalyze its break up on ideological grounds in the Bangladesh War. Pakistan, similarly hoped to re-open the disputed Kashmir conflict with India after it developed a nuclear capability.[190]

In a classic internal balancing act, India revived its nuclear weapons program after Indira Gandhi's was re-elected to power in 1980.[191] Gandhi's government also instituted a ballistic missile program in 1983. The Indian Air Force made purchases of dual-use combat aircraft

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[185] Perkovich, "India Explodes a 'Peaceful' Nuclear Device," *India's Nuclear Bomb,* pp. 170-189.
[186] Ibid.
[187] L.K. Jha, "Nuclear Policy," *Prime Minister's Secretariat*, May 3, 1967 (P.N. Haksar Files, Sub. F. – 111, Nehru Memorial Library, New Delhi).
[188] Perkovich, *India's Nuclear Bomb,* pp. 121, 173-174.

[189] Ibid., pp. 173-174.
[190] "The Nuclear Backdrop," *From Surprise to Reckoning: Kargil Review Committee Report,* pp. 185-187.
[191] Ibid., pp. 199-206.

capable of performing nuclear missions. These programs were ostensibly part of a balancing response against Pakistan's nuclear developments. India's "option" strategy as it became subsequently known, was interpreted from the outside as an attempt to assemble all the components of a working nuclear arsenal; a threshold capability that would give New Delhi the technical means to develop and deploy an arsenal rapidly. The option strategy was also thought more economically manageable and far less likely to attract international "negative" balancing efforts in the form of sanctions.

The baseline assumption among most analysts was that India's response fit neatly into the standard rational-actor model. The trouble with this assumption as the subsequent evidence makes clear is that Indian decision-makers' notions of rationality were more imagined than real. The nuclear weapons development program was never clearly tied to the development of delivery systems. The weapons built in the nuclear lab did not fit onto dual-use combat aircraft. The ballistic missiles proved unsuitable for nuclear delivery. Further, prime ministers and their top advisors had unrealistic assumptions about the time it would take Pakistan to build nuclear weapons and the time by which India could counter an operational Pakistani nuclear threat. Whereas Pakistan acquired the ability to enrich uranium to weapons-grade in 1985, India did not obtain an uninterrupted supply of weapons-grade plutonium until 1988. Whereas Pakistan acquired nuclear devices sometime in 1987, a comparable Indian capability emerged only in 1990. For at least three years, India was vulnerable to a Pakistani nuclear threat.

How did India, a country with a proven nuclear weapons capability and a much larger nuclear estate and scientific-industrial infrastructure end up in a position of weakness against

Pakistan, its much smaller and less materially endowed neighbor? In this chapter I answer that question by showing that the institution of secrecy disrupted parallel coordination between India's nuclear estate, its defense agencies and its military. I also present evidence to show that sequestered decision-making and the regime of information scarcity produced biases, which led Indian decision-makers into underestimating Pakistan's nuclear potential while overestimating India's own nuclear breakout capabilities. Finally, I show that the compartmentalization of information and the lack of institutional scrutiny due to secrecy severely complicated the task of managing the nuclear weaponization program successfully.

Secrecy, Compartmentalization and the Disaggregated Nuclear Knowledge Market

India revived its nuclear weapons program in 1980-81. However, the program operated under a regime of severe internal opacity, which disrupted parallel coordination within the state. Between 1980 and 1989 less than a dozen individuals had knowledge of the program. Initiation of the nuclear weapons (1981) and missile development programs (1983) occurred in sequential order. However, tasking requirements for the two programs proceeded on parallel tracks and were weakly coordinated. Strong internal firewalls also disrupted cooperation between the high-tech civilian space agency, the Indian Space Research Organization (ISRO), and the missile development agency, Defense Research & Development Laboratory (DRDL). Within the armed services, the air force continued with routine equipment acquisition and modernization programs without accounting for the challenges of potential nuclearization fully. Similarly, limited feedback loops between the agencies tasked with weapons development and the central executive coordinating arm of the government, the Prime Minister's Office (PMO), restricted the latter's independent scrutiny of the inputs it received from the former on the likelihood and potential effects of

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external sanctions, the state of Pakistan's nuclear progress or the speed at which India could resolve its own weaponization challenges.

That fear stemmed from the belief among India's top decision-makers that discovery of the program would trigger technological and economic sanctions from the US and its western alliance partners. The resulting sanctions would cripple India's nuclear power sector and other high-tech sectors; and that economic sanctions would cause severe dislocations in the Indian economy. Such fears forced the program underground. The secrecy and sequential planning had three effects. First, Indian leaders approached the nuclear weaponization program in increments. For the most part, they did not actively mobilize a nuclear epistemic community beyond the handful of nuclear scientists involved in the weapons development program. The latter condition constricted the process of learning among decision-makers. Second, even among actors with knowledge of the program, restrictions on the free flow of information became an institutional roadblock for coordinating action between them. Third, the principals in the PMO sought to safeguard the secrecy of the program as well as their own autonomy by keeping the process of policy planning and decision-making weakly institutionalized. As a result, the epistemic actors with stakes in the program never acquired the institutional means to extract policy commitments from the principals. This last condition not only affected their morale negatively, but it also prevented them from monitoring the performance of the decision-makers effectively.

This regime of internal opacity itself was substantially the child of fear born in the aftermath of India's 1974 nuclear test explosion. In its wake, the US led its alliance partners to deny sensitive nuclear fuel cycle technologies and equipment to states that did not accept full-

scope International Atomic Energy Agency (IAEA) safeguards on their nuclear facilities. Nonproliferation pressures built up slowly: first through the Zangger Committee[192] and then the Nuclear Suppliers Group.[193] Further pressure came after the US Congress passed the Nuclear Nonproliferation Act (NNPA) in 1978. The NNPA changed US domestic law and forbade the supply of nuclear materials, equipment and technology to countries, which did not accept full-scope IAEA safeguards.[194] As international collaboration dried up, India's Department of Atomic Energy (DAE) was unable to meet the planned power generation target of 4,500MW in the period 1970-1985. In 1985, a decade after the 1974 test, Indian nuclear reactors produced a mere 1,500MW of power, one-third the original target. And the figure in 2000 was only 2,800MW.[195]

Although the nuclear sector was the sole target of western technology-denial policies, yet the tightening of equipment, spares and nuclear material had a sobering effect on Prime Minister Indira Gandhi and her close policy advisors. Within India's space agency, for example, there was great concern that the fate of the nuclear sector would befall it as well. Vikram Sarabhai,

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[192] The Zangger Committee was formed between 1970-1974 by a group of advanced industrial countries to regulate the supply of fissile material and equipment that could be used to process fissile material to any non-nuclear state unless the equipment or fissile material was subject to international safeguards. See, "Communication Received from Members Regarding the Export of Nuclear Material and of Certain Categories of Equipment and Other Material," *International Atomic Energy Agency Information Circular,* INFCIRC/209, September 3, 1974, http://www.fas.org/nuke/control/zangger/text/inf209.htm (May, 2013).

[193] The Nuclear Suppliers Group was formed in 1975 by a group of advanced industrial countries to coordinate their export control policies on the supply of nuclear material and sensitive nuclear fuel-related technologies and equipment to non-nuclear states. See, "The Nuclear Suppliers Group At a Glance," *Arms Control Association*, October 2012, http://www.armscontrol.org/factsheets/NSG (May, 2013).

[194] See full text of the 1978 NNPA in, "Nuclear Regulatory Legislation," *United States Nuclear Regulatory Commission*, NUREG-0980, Vol. 3, No. 10, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/v3/sr0980v3.pdf (May, 2013).

[195] Parthasarathi, "Atomic Energy," *Technology At The Core,* p. 106.

the founder of the agency had opposed the nuclear explosives program on normative

grounds. He had also argued against nuclear testing on grounds that building nuclear

explosives was premature in the absence of supporting infrastructure that would enable

India to field a nuclear force.[196] His successor Satish Dhawan, similarly opposed any

militarization of the civilian space agency.[197] When Prime Minister Indira Gandhi authorized

a secret medium-range ballistic missile program (Valiant) in 1972 using INR 60 million from

the prime minister's "apex fund,"[198] Dhawan ensured that firewalls were erected between

India's space and missile development agency. In the mid-1970s, engineers from the civilian

space agency, ISRO and the Indian Institute of Science (Bangalore) conducted a peer review

of the missile's liquid rocket engine.[199] However, Dhavan and his team avoided incorporating

the engine developed for the Valiant rocket into the polar satellite launch vehicle (PSLV)

program during the 1980s. For the latter, ISRO contracted to purchase the French Viking

liquid fuel engine from Ariane, the French aerospace agency. As Indira Gandhi's scientific

advisor at the time saw it, the missile development agency, the Defense Research &

Development Laboratory (DRDL), became a victim of its own success. The prime minister,

despite her wishes to the contrary, hesitated from forcing coordination and cooperation

between the civilian ISRO and military DRDL.[200]

In 1977, Indira Gandhi lost elections to Morarji Desai, a Gandhian who was morally

opposed to the 1974 test and the nuclear weapons program in general. During his two-year

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[196] See Vikram Sarabhai's press statements cited in, Perkovich, "War and Leadership Transitions," p. 121.

[197] Parthasarathi, "Defense," *Technology At The Core,* pp. 172-73.

[198] Ibid., pp. 170-171; Chengappa, "Build an ICBM or I'll Shut Down the Lab," *Weapons of Peace,* pp. 131-145.

[199] Chengappa, "The Devil's Workshop," *Weapons of Peace,* pp. 169-174.

[200] Parthasarathi, "Defense*,"* pp. 171-180.

tenure, the nuclear test team almost disintegrated due to his inattention and vocal opposition to the program. Despite the mounting threat from Pakistan, Desai removed the leader of the test team, Dr. Raja Ramanna out of the Bhabha Atomic Research Center (BARC)[201] to the position of scientific advisor to the defense minister.[202] In a public display of displeasure with the nuclear weapons establishment, the prime minister mocked the achievement of Indian nuclear weaponeers and publicly claimed he was uncertain whether the 1974 test was caused by a nuclear device or by conventional explosives.[203] Nuclear scientists at BARC complained that they worked very hard during Desai's tenure to keep the 1974 nuclear engineering and physics team intact.[204]

Between 1977-1979 evidence mounted of Pakistan's nuclear quest. In 1979, India's Joint Intelligence Committee (JIC) chaired by K. Subrahmanyam conducted its first thorough review of this development and concluded that Pakistan was pursuing a weapons programs through the gas centrifuge uranium enrichment technique. US officials informed the Indian foreign minister A.B. Vajpayee during his visit to Washington they believed that Pakistan could conduct a nuclear explosion within two or three years.[205] But Desai's government did not act on the JIC's report.[206] However, Indira Gandhi, who was re-elected to power in 1980, did not share Desai's moral aversion to nuclear weapons. Confronted by nuclear

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[201] BARC is the nerve center of India's nuclear weapons design and development program.
[202] Bharath Karnad, "Hesitant Nuclear Realpolitik: 1966-To-Date," *Nuclear Weapons and Indian Security: The Realist Foundations of Strategy,* (New Delhi: Macmillan, 2002), pp. 338-344; Chengappa, "Hello, Mr. Bomb," *Weapons of Peace,* pp. 218-219.
[203] The spokesman for India's Department of Atomic Energy responded to Desai's statement by saying: "the funniest thing I have heard so far." See, "Desai Claims He Has Some Doubts About India's Nuclear Test in '74," *New York Times,* June 3, 1981 http://www.nytimes.com/1981/06/03/world/desai-says-he-has-some-doubts-about-indian-nuclear-tests-in-74.html, (May, 2013).
[204] Chengappa, "Hello, Mr. Bomb," p. 219.
[205] "The Nuclear Backdrop," *Kargil Review Committee Report,* p. 186.
[206] Ibid.

developments in Pakistan and warnings from the nuclear establishment and India's intelligence agencies, she revived the nuclear weapons program and re-appointed Ramanna as director of BARC.[207] However, in doing so, she continued a pattern of secrecy and sequential decision-making. This method had a precedent in the 1974 test. But its urgency was even greater in light of US nonproliferation pressures, the reality of technology denials in India's civilian nuclear power sector and the potential threat of economic sanctions.

In reviving the nuclear weapons program, Gandhi ensured that goals were static and loosely coupled. To avoid attracting international attention, the principal challenges of the program – fissile material production, device development, delivery system modification, force planning, command and control -- were all divvied up and dealt with sequentially. In the absence of a holistic approach to finding solutions to the challenge posed by the emerging Pakistani threat, the PMO deliberately mobilized only those epistemic actors that were absolutely essential for the program's early stages – the nuclear physicists at BARC. The DRDO and a few of its labs were gradually brought into play. But high firewalls were left standing between them. The government also did not consider it prudent to coordinate action between the weapon development team, the team working on potential delivery systems and their actual users. All information was hived off in compartments with little interflow between them. The net result of this approach was a regime of severe internal opacity, which rivaled and eclipsed the cloak of external invisibility.

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[207] Ibid., pp. 199-200; Chengappa, "Do You Want Our Skulls Cracked?" *Weapons of Peace*, pp. 246-247; Perkovich, "More Robust Nuclear Policy Is Considered," *India's Nuclear Bomb,* pp. 227-232.

For secrecy reasons, the weapon program's objectives were never debated seriously in the cabinet, parliament, the committee of government secretaries (cabinet secretariat), or by the chiefs of staff. Nothing was committed to paper and all sensitive questions concerning the program were decided between the Prime Minister, the Chairman of the Atomic Energy Commission (AEC) and the director of BARC. The chief of DRDO, who also doubled up as Science Advisor to the Defense Minister, was part of the technical circle of advisors because the agency was tasked with developing the non-fissile triggers for the experimental devices under development. However, the DRDO chief's political overlord, defense minister R. Venkataraman, had only occasional knowledge of nuclear developments such as an impending nuclear test.[208] Other decision-makers included the members of the prime minister's inner circle such as the cabinet secretary, her principal secretary and occasionally her economic advisor.[209] The prime minister's Principal Secretary and the Cabinet Secretary also represented the PMO on the board of the AEC. However, given their non-technical status, the degree to which both were aware of the scope of the covert nuclear weapons program is debatable.[210] For the most part, the director of BARC and the chairman of the AEC were the two individuals privy to details of the program.[211]

In 1985, Prime Minister Indira Gandhi's son and successor experimented with a weakly institutionalized system of nuclear decision-making for a six-month period. Gandhi's informal 'Policy Planning Group' consisted of two political leaders, the Cabinet Secretary,

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[208] R. Venkataraman, "Ninth General Elections," *My Presidential Years*, (New Delhi: HarperCollins Publishers India, 1994), p. 323.
[209] Perkovich, "More Robust Nuclear Policy Is Considered," pp. 242-244.
[210] Dr. P.K. Iyengar, Chairman, Atomic Energy Commission/Secretary, Department of Atomic Energy (1990-1993), interview with author, June 20, 2010, Mumbai, India.
[211] Dr. M.R. Srinivasan, Chairman Atomic Energy Commission/Secretary, Department of Atomic Energy, Government of India (1987-1990), interview with author, July 8, 2010, Bangalore, India.

the Chairman, CoSC, the chiefs of the AEC and intelligence agencies, the Chief Economic Advisor and director of the defense ministry's think tank, the Institute of Defense Studies & Analyses (IDSA). However, Gandhi ended the experiment within six months and returned to the precedent of making decisions on the basis of consultations with his scientific and technical advisors.[212] The available evidence suggests that the PMO did not make any deductive assessment of the type of weapons the Indian military might require in the Pakistan and China theaters. Such assessments could only have been possible through joint consultations between the PMO, the military and the scientists. However, the three cooperated only briefly to prepare a potential nuclear force sizing and cost estimate for the PMO in 1986.[213] Dr. A.N. Prasad who years later served as the director of BARC complained "…the government set the Department of Atomic Energy no tasks, oversaw no military developments."[214] Nuclear scientists therefore proceeded with weapon designs without consulting the user services such as the air force from which combat aircraft would most likely be drawn for nuclear missions; or the DRDL that would supply rockets for delivering nuclear warheads.[215]

SEE SCHEMATICS 1 & 2 FOR VISUALIZATION OF <u>OPTIMAL</u> VERSUS <u>ACTUAL</u> INDIAN NUCLEAR DECISION-MAKING

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[212] Chengappa, "The Reluctant Believer," *Weapons of Peace,* pp. 294-305; Perkovich, "Nuclear Capabilities Grow," *India's Nuclear Bomb*, pp. 273-276.
[213] Ibid.
[214] Bharath Karnad, "Maturing Nuclear and Missile Capabilities," *India's Nuclear Policy*, (New Delhi: Pentagon Press, 2008), p. 80.
[215] Ibid., p. 82. The lowering of internal firewalls between BARC and India's missile agency occurred around 2002-2003. According to Indian missile scientists and engineers, the phenomenon of high firewalls prevented optimization of nuclear missile designs until then.

The revived nuclear weapons program centered on the reduction in the size and weight of the 1974 fission device. It also very likely involved the design of a new device on the principle of fission boosting. Nuclear tests were planned in 1982-83 and new shafts were sunk at Pokhran for the purpose.[216] However, the revived program was considered experimental; not one that would produce weaponized devices immediately. Thus there was no broad coordination among the nuclear and defense R&D agencies to make the weapons rugged and deliverable. There was also no open debate on a viable long-term strategy for the nuclear weapons program. In fact, the AEC was divided on the overall direction of India's civilian nuclear power program and how that might parlay into the production of fissile material for a weapons program. AEC Chairman Sethna and BARC Director Ramanna led the dominant faction within the AEC, which favored sticking with India's originally planned path of atomic energy development: the three-stage program with natural uranium heavy water reactors, fast breeder reactors and thorium reactors.[217] This approach would also produce weapons-grade plutonium for a weapons program in the long-term. However, a second school favored the light-water reactor (LWR) route using LEU. The Soviet Union offered to build LWRs for India under conditions that such reactors be placed under international safeguards. The Soviet Union was also prepared to relax the condition of full-scope safeguards to build such reactors in India. The latter route was favored by the M.R. Srinivasan faction and viewed as the means for reviving the nuclear power program, which had stalled in the wake of the 1974 test explosion.[218] However, the latter approach implied bifurcating the power and fissile material production programs. But there was no debate

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[216] Perkovich, "More Robust Nuclear Policy Is Considered," pp. 242-244.

[217] Raja Ramanna, "Gangotri and Gomukh," *My Years of Pilgrimage,* (New Delhi: Viking, 1991), pp. 109, 115.

[218] M.R. Srinivasan, "Soviet Light Water Reactors," *From Fission to Fusion: The Story of India's Atomic Energy Program*, (New Delhi: Viking, 2002), pp. 182-192.

outside the AEC and Prime Minister Indira Gandhi did not come down in favor of either. Her successor Rajiv Gandhi favored the LWR plan as a means of reviving the nuclear power sector. However, the new prime minister's inclination caused serious fissures between the AEC leadership, especially between Ramanna and the prime minister,[219] further dampening the drive toward information cooperation between the agencies.

Even as India revived an experimental nuclear weapons program in 1981, decisions on potential delivery systems for those weapons were pushed further down the road. In 1983, the Indian government launched the Integrated Guided Missile Program (IGMDP)[220] under DRDO's direction. This was a continuation of the ballistic missile programs from the1970s. However, the IGMDP envisaged the development of a diverse array of missile systems: anti-tank, air defense and two ballistic missile programs. The ballistic missile programs, the short range Prithvi[221] and the medium-range Agni[222] had strategic implications as potential carriers of nuclear munitions. However, in the absence of strategic direction from the government, DRDO sold the short-range Prithvi to the services as a version of long-range artillery.[223] On the other hand, the Agni, with its longer range, actually held greater promise as a potential nuclear delivery system. But it was conceived as a "technology demonstrator," a proving ground for technologies and sub-systems.

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[219] Ramanna, "Gangotri and Gomukh," p. 115; Srinivasan, "Soviet Light Water Reactors," p. 184.
[220] Indranil Banerjee, "The Integrated Guided Missile Development Program," *Indian Defense Review,* July 1990, pp. 99-109.
[221] "Prithvi," *The Integrated Guided Missile Development Program*, (Delhi: Defense Research & Development Organization, 2008), pp. 63-109.
[222] "Agni," *The Integrated Guided Missile Development Program*, pp. 110-116.
[223] "Prithvi," *The Integrated Guided Missile Development Program.*

Table 3

Indian Ballistic Missile Programs (1970-1990)

Year	Name	Type	Range
1973	Valiant	Liquid Fuel	Medium-Range
1983	Prithvi	Liquid Fuel	Short-Range
1983	Agni Technology Demonstrator	Solid Fuel	Medium-Range

The compartmentalization between the missile and nuclear agencies, the DRDO and BARC, is evident indirectly from the weight and size of India's fission warhead design in the 1980s. DRDO's missiles were designed to carry a generic one-ton payload, the presumed weight of a first-generation nuclear warhead. However, warheads designed for missiles place greater demands on design and shape requirements compared to aircraft.[224] Such warheads must of necessity fit into the narrow cone of the missile's warhead casing; and they must be sufficiently rugged to withstand the shock of vibrations and the heat of re-entry during flight. According to a senior air force officer with some knowledge of the program, the weight of the first nuclear bomb was between 1,000-1,500kg.[225] Had missile carriage been the intent, BARC would have designed a lighter warhead. Further, the DRDO's missile development and BARCs' warhead design schedules proceeded independently of each other. For example, India commenced weaponization in the spring of 1989. However, the Prithvi's testing and certification schedule continued until 1994-1995. It was not until the late 1990s,

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[224] Verghese Koithara, "Nuclear Hardware," *Managing India's Nuclear Forces,*(Washington, D.C.: Brookings Institution Press, 2012) p. 126.

[225] Air Marshal 'N', non-attributable interview with author, January 2010, New Delhi, India.

most likely around 1996-1997 that nuclear warhead trials commenced for the Prithvi.[226] On

the other hand, the testing of the Agni technology demonstrator began in 1989 and ended in

1994 after which the government authorized DRDO to begin development of a follow-on

all solid-rocket motor ballistic for operational deployment.[227]

The first weapon was designed with the air force's Jaguar in mind. However, high internal

firewalls and information compartmentalization precluded information sharing between the

BARC and the air force. The weapon that emerged out of BARC had a diameter that was

too large for carriage beneath the aircraft as it left very little ground clearance. Of the early

trials in the 1980s that DRDO conducted to test the potential for the Jaguar to serve as a

potential delivery system, a test pilot on the team had this to say:

> "we were groping in the dark. We had no interaction with the scientists who were
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> actually making the bombs. They had never flown an aircraft and we were not involved
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> in the bomb's development…we argued that unless we knew what the left hand is
>
> doing how can the right hand bring it together."[228]

Between 1987-1990, DRDO borrowed a Mirage 2000 from the air force to test its feasibility

to perform nuclear missions.[229] However, DRDO circumscribed the test pilot and squadron

base commander's communications with Air Headquarters in Delhi. Outside India it was

presumed was that India's Jaguar and Mirage 2000 aircraft purchased from Britain and

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[226] Chengappa, "Why Play Pahalwan?" *Weapons of Peace*, p. 406.
[227] Chengappa, "Tell Your President, I Keep My Word," *Weapons of Peace,* p. 387.
[228] Chengappa, "The House Is On Fire," *Weapons of Peace,* p. 327.
[229] Senior Indian air force officer 'S', non-attributable interview with author, December 2008, New Delhi, India.

France were nuclear-capable, providing India with a rapid nuclear breakout capability. According to senior air force officers closely associated with negotiating the Jaguar and Mirage deals during in the 1970s and the early 1980s, there was only a generic query from the government about nuclear feasibility. The air force was not tasked to perform detailed feasibility studies on conversion of the aircraft for nuclear missions.

The disaggregation within India's strategic technical estate was not an exception. India's policy knowledge market was equally fragmented. For example, the Indian military's inputs on the security implications of the impending Pakistani nuclear revolution did not receive a full hearing within government until the latter half of the 1980s. Despite remaining on the policy sidelines, the army instituted an 'Experts Committee' in 1975 to plan for modernization in the 21st century. One section of the report that came out of that process dealt with India's nuclear response to regional threats.[230] Although the army submitted its report to the civilian ministry of defense in 1976, the latter did not pass on the plan to the PMO for consideration. It wasn't until 1982 that then army chief Krishna Rao who was also Chairman, CoSC, brought the army's recommendations to Prime Minister Indira Gandhi's attention and briefed her on its sensitive nuclear contents.[231]

Beginning in the early 1980s the Indian army began experimenting with a mobile defense and offense-in-depth conventional war strategy based on mechanization that was supposed to be conducive to conducting conventional operations under nuclear, biological and

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[230] Chengappa, "Do You Want Our Skulls Cracked?" *Weapons of Peace*, pp. 253-255.
[231] As the army chief summed it: "The chiefs of staff had taken up the case with the prime minister that we must go nuclear. Before this, the military had never made a suggestion like this. I must add that was also a part of the Expert Committee's recommendations. See, "China Was the Real Concern: In Conversation with Gen. K.V. Rao" *Force*, (December 2004), p. 31; Chengappa, "Do You Want Our Skulls Cracked?" p. 255.

chemical warfare conditions against Pakistan. In the Army's College of Combat at Mhow, Lt.

General Sundarji kicked off a series of seminars on conventional operations under

conditions of nuclear asymmetry, which became the basis of the famous *Mhow (Combat)*

Papers and the core of his subsequent nuclear advocacy and strategy for India.[232] Sundarji's

central argument was that India's conventional superiority would cease to matter under

conditions of nuclear asymmetry as the army would be unable to concentrate in mass for

fear of nuclear annihilation. Scattering forces to reduce the army's vulnerability to a potential

nuclear attack would allow the enemy (Pakistan) to chew up Indian forces piecemeal.[233]

However, Sundarji's was a private effort driven by his own academic interest in nuclear

weapons and warfare. Due to the lack of any strategic direction from the government there

was no institutional attempt to provide military officers with training on the subject at staff

colleges.[234] Sundarji's arguments only received full attention after he became army chief in

1986 and came to enjoy the backing of the Minister of State for Defense Arun Singh who

ran the ministry on behalf of the prime minister who nominally held the cabinet post for

defense.[235] However, the military chiefs had no formal means of bringing their concerns

before the cabinet. Nor did the PMO solicit their opinion.

The disaggregation of the state's nuclear epistemic communities apart, those elements of it

that were mobilized on occasion were weakly institutionalized within the state. They had no

administrative, legal or institutional means to extract political commitments from the

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[232] Lt. General K. Sundarji ed., "Effects of Nuclear Asymmetry on Conventional Deterrence," *Combat Paper,* No.1, Mhow, April 1981.

[233] Ibid; K. Sundarji, "Can Non-Nuclear India Fight Nuclear Pakistan?" *Blind Men of Hindoostan,* (New Delhi: UBS Publishers, 1993), pp. 21-48.

[234] K. Subrahmanyam, interview (1) with author, October 2009, Noida, India.

[235] Deshmukh, "Economic and Defense Matters," *A Cabinet Secretary Looks Back,* pp. 163-166.

political leadership. Commitments, as argued earlier in Chapter Two, are "time lengthening" mechanisms, which signal the strength of decision-makers' commitment to resolving problems. Epistemic actors, as knowledge brokers and specialists, are the ones most committed to holistic solution sets and suffer loss of morale when they find such commitments lacking. This is evident from the Indian case as well. Two episodes highlight these dynamics during the 1980s. In late 1982 for example, Prime Minister Indira Gandhi approved a program of nuclear tests. However, she retracted her decision within a day of making it. The DRDO chief, V.S. Arunachalam who was privy to that episode recalls the emotional impact of that decision on him and other members of the nuclear epistemic community. In his words:

"Once we were to ready to test for the first time…myself, Dr. Ramanna…in 1982. Ramanna who pressurized it insisted that I follow it up with Mrs. Gandhi, why we should test it…it is important and so forth…reduction in size, increased efficiency etc. etc. I don't want to mention who all else were sitting in that meeting. Mrs. Gandhi said yes and Ramanna rushed to Bombay to get things organized. And I went to another location to organize a few other things. In the evening my defense minister Venkataraman called me. He called me and said: It's off. I asked: what is off sir? He said the testing is off. I said that the PM gave her yes during the meeting. He said but now she has changed her mind. So I rang Dr. Ramanna. He just was so furious. He said: No! Go seek an immediate appointment with the prime minister and talk to her. He was in Bombay and trying to come by the next flight. So I went to my minister and said: is it alright sir if…can I meet the prime minister. He said: the prime minister doesn't want to see you…very clearly. And I told Ramanna: I couldn't get an appointment…it is up to you. The next morning he [Ramanna] comes to my house and

after breakfast says: this is not right…I am going to see…I have asked for an appointment…I think it was…the prime minister's secretary was there. But the appointment never came. It was over. I saw the prime minister many times after that. I decided that I will not ask her. If she doesn't want to see me on this…I have my own pride and I am not going to ask her why did she said no."[236]

K. Subrahmanyam, who participated in Rajiv Gandhi's 'Policy Planning Group' for a short six-month period in 1985, similarly recalled the emotionally enervating effect of weak institutions on epistemic actors. In Subrahmanyam's recollections of those meetings:

"…the person who was opposed to it [India going nuclear] was the economic advisor…Jalan. Most of the people kept silent. Ramanna [Chairman, AEC] didn't say anything. But everyone knew Ramanna's views that he was in favor of development. I know Arun Singh [Minister of State for Defense] was in favor of development…but I don't remember his saying anything in public. The Cabinet Secretary was against it and the intelligence chief didn't say anything openly. But I know that he, Gary Saxena, was for it. And I think the Intelligence Bureau chief also should have been for it.

The main problem is that in a meeting like this with the prime minister presiding over the meeting, you don't find many people talking very freely. Of course I was the exception. Most people weren't sure what the prime minister's opinion was. And I have a feeling…guess…they didn't want to…if they hadn't already taken a stand like

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[236] Dr. V.S. Arunachalam, Scientific Advisor to Defense Minister/Secretary, Defense Research & Development Organization (1983-1992), interview with author, May 19, 2009, Bangalore, India.

Ramanna and myself…they didn't want to take a stand in contradiction of the prime minister's opinion. They wanted to play safe…"[237]

The Downside of Sequestered Decision-Making and Inferences Drawn From Value Judgments

The fundamental challenge before Indian decision-makers in the 1980s was one of uncertainty. The uncertainty stemmed from imperfect information concerning: (a) how the United States would respond to an Indian nuclear weapons program; and (b) the progress and state of Pakistan's nuclear program. Cybernetic decision-making models suggest that decision-makers in isolated settings routinely attempt uncertainty control by simplifying the ambiguity that surrounds them. They do this by using highly selective channels to screen incoming information in order to ensure consistency of their belief systems. Cognitive psychology also informs us that in conditions of ambiguity, decision-makers resort to heuristics and biases and substitute knowledge gaps with value-based judgments.

In India, the regime of severe internal opacity limited the extent to which decision-makers could seek feedback from within and outside the state. Further, given the dilemmas of incomplete information, the decision-makers essentially substituted factual assessments with value judgments based on anchoring and availability heuristics. The latter were based on memories anchored in India's 1974 nuclear test and the very real threat of US technological sanctions, proven by the ruin of India's civilian nuclear power sector. Equally significant, the decision-makers' beliefs were also anchored in India's vast nuclear and rocket technological

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[237] K. Subrahmanyam, interview (2) with author, October 2009, Noida, India.

estate, which could have produced nuclear weapons and rockets to deliver them with relative ease and the relatively thin Pakistani nuclear and missile infrastructure by comparison.

This brute material reality had three bias effects. First, it produced over-caution in the minds of Indian decision-makers about what might or might not the United States do.[238] Second, it led them to overestimate India's indigenous nuclear breakout capability. And third, it produced a bias train, which led them to underestimate Pakistan's capacity to produce nuclear weapons. The net result of this approach was that despite India's vast technological and resource advantage over Pakistan, it found itself without nuclear weapons when confronted with Pakistani nuclearization in 1987. As the doyen of Indian strategic analysts K. Subrahmanyam subsequently disclosed: "in the period between 1987-1990 India was totally vulnerable to a Pakistani nuclear threat."[239]

From the late-1970s, the threat of US sanctions was very real. For example, international collaborators, who prior to the 1974 nuclear test had participated eagerly to help India build up the complete nuclear fuel cycle, train its scientists and engineers and set up a vast ancillary infrastructure, withdrew their cooperation as India became the exemplar of the dangers of the dual-use 'Atoms for Peace' program. Although Indian nuclear scientists and political leadership had aspired to make the nuclear program self-sufficient, they were almost entirely dependent on foreign, particularly western assistance. India's first swimming pool-type reactor was built almost entirely with British assistance.[240] Canada built the 40MW CIRUS

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[238] Scholars such as Sumit Ganguly believe that Indian decision-makers' assessments of the threat of US sanctions were correct.

[239] K. Subrahmanyam, "Indian Nuclear Policy – 1964-98 (A personal recollection)," in Jasjit Singh ed., *Nuclear India*, (New Delhi: Knowledge World, 1998), p. 44.

[240] Abraham, "Postcolonial Modernity," *The Making of the Indian Atomic Bomb*, pp. 82-86.

research reactor at Trombay, which later provided the plutonium for India's 1974 test.[241] General Electric from the United States built the first power generation reactors at Tarapur on a "turnkey" basis.[242] All the reactor's components including the supporting equipment and machinery was imported. Similarly, the first unit of the heavy water reactor in Rajasthan was a Canadian import. Indian engineers worked under Canadian supervision. But India did not gain design competencies or outfit the plant with any indigenous machinery or equipment.[243]

This heavy dependence on foreign suppliers, design and engineering expertise caused the entire program to sputter once external assistance ceased. There was another reason that compounded the nuclear power sector's weak performance. Indian nuclear scientists starting with Homi Bhabha had oversold the benefits of cheap nuclear power to their political overlords in the 1950s and 1960s.[244] In their eagerness to prove nuclear energy's viability against alternatives they embraced relatively untried and untested technologies. According to Ashok Parthasarathi who advised the PMO on scientific issues, there was no "operational feedback" on the reactor India bought from the Canadians. Thus serious engineering problems cropped up in the wake of operating this "premature Canadian technology."[245] Examples of these problems included the cracking of the reactor's end shield and the poor performance of the "zero leak" pumps and valves used to circulate the reactor's heavy water.[246] Leaky valves and the discharge of highly radioactive waste caused serious

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[241] Ibid. pp.86-91, 120-124.
[242] Perkovich, "Developing the Technological Base," *India's Nuclear Bomb*, pp. 49-59.
[243] Parthasarathi, "Atomic Energy," pp. 115-117.
[244] Abraham, Postcolonial Modernity,"; pp. 91-98; Parthasarathi, "In the Department of Atomic Energy," & "Atomic Energy," pp. 18-19, 118-125.
[245] Parthasarathi, "Atomic Energy," pp. 115-16.
[246] Ibid.

operational problems in the Tarapur reactors as well.[247] Resolution of these design and operational problems took over a decade of trial and error. Further, it took India's DAE 12 years to build a heavy water reactor indigenously after Canada withdrew assistance in 1976[248]. Similarly, India's heavy water plants and the plutonium reprocessing facility at Trombay also performed below par.[249]

However, western technology denials in the wake of the 1974 test were a mixed bag. Western collaborators did not immediately end civil nuclear cooperation with India. Although Canada ended cooperation on the second phase of the Rajasthan atomic power project, the United States continued supplying low-enriched uranium (LEU) for the Tarapur reactors. In the early 1980s as the supply of LEU became increasingly contested in the United States due to congressional pressure, the Reagan administration allowed India to negotiate a substitute nuclear supply agreement with France. Further, the technology export control regime the United States instituted to deny the sale of sensitive technologies was not watertight. For example, a CIA report from the early 1980s concluded that India was relatively immune to US supplier disruptions due to the existence of an international "grey market." As the report put it:

> "Largely through the use of the international 'grey market', India has been able to
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> maintain a nuclear weapons capability…India's purchasing activities challenges US

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[247] Ibid., pp. 110-112.
[248] Parthasarathi, "Atomic Energy," pp. 117-118; Perkovich, "The Nuclear Program Stalls, *India's Nuclear Bomb*," pp. 197-199.
[249] Parthasarathi, "In the Department of Atomic Energy," pp. 17-18; Perkovich, The Nuclear Program Stalls, p. 201.

efforts to work with other nuclear supplier states for tighter export controls and demonstrate that the Nuclear Suppliers Guidelines have serious weaknesses.

India has evaded Western supplier-state export and nonproliferation controls by avoiding government-to-government agreements and not importing complete nuclear facilities. Instead, India has established direct relations with foreign vendor firms, used intermediaries to disguise the end use of its purchases, and bought many components piecemeal." [250]

The report further stated:

"…we expect the European exporting countries and Japan to continue to resist US efforts to curb their nuclear exports by arguing that they will be replaced by the Soviets in the Indian market if they are curtailed."[251]

In a "grey market" the acquirer states violate the spirit if not the letter of the supplier state's export control laws. Equipment is purchased from private vendors piece-by-piece, subsystem-by-subsystem or component-by-component. Export controls that would normally apply to the sale of a complete nuclear reactor or reprocessing plant do not apply to individual components such as pressure valves, vessels, control instruments that could be incorporated into such plants.[252] Indeed, starting in 1976, Pakistan systematically imported an entire gas centrifuge uranium enrichment plant piece-by-piece from Western Europe based

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[250] "India's Nuclear Procurement Strategy: Implications for the United States," *Directorate of Intelligence*, CIA-RDPS00854R00020012000-0 (Approved for Release: July 1, 2011), p. iii.
[251] Ibid., p. 12.
[252] Ibid., p. 6.

on vendor lists pilfered by A.Q. Khan out of the Netherlands.[253] Equally significant, India's missile agency learnt lessons from the case of sanctions applied to the nuclear sector. Anticipating technology denials for India's ballistic missile program in the 1980s, the DRDO set up a 'Special Purchase Team', which stocked up on gyros, accelerometers, hydraulic actuators, computers, motion simulators and three-axis measuring machines from Sweden, France, United States and West Germany.[254] For the critical carbon-carbon heat shield on the long-range Agni's re-entry vehicle, the team purchased a special six-axis filament-winding machine with computer controllers in the United States. In order to escape scrutiny from US export control authorities, the machine was routed through an Indian textile manufacturer.[255]

Indian nuclear and missile entities were aware of the complexities of the international technology market and the manner in which export controls could be circumvented. The scientists had far greater confidence that India could proceed with a nuclear weapons program and overcome the retarding effects of technology sanctions.[256] However, the debilitating effects of technology denials anchored the PMO's view that scientists had oversold the nuclear power program. Despite promises that they could resolve technological problems, they had proved unsuccessful. Similarly, the PMO's nuclear hesitancy was anchored in the threat of the potential denial of World Bank loans and the IMF's restructuring package by the United States. These, the PMO believed, could damage the Indian economy seriously.[257] Reflecting these fears, the prime minister remarked rhetorically

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[253] For details of Pakistan's clandestine procurement efforts see, Leonard S. Spector, "Pakistan," *Going Nuclear*, (Cambridge: Ballinger Publishing Company, 1987), pp. 113-117; Sreedhar, *Pakistan's Bomb: A Documentary Study*, (New Delhi: ABC Publishing House, 1986).
[254] Chengappa, "The Funny Guys Did It," *Weapons of Peace*, pp. 314-315.
[255] Chengappa, "The Agni Pariksha," *Weapons of Peace,* pp. 346-347.
[256] Srinivasan, "The Nuclear Weapon," *From Fission to Fusion*, p. 271.
[257] Perkovich, "More Robust Nuclear Policy Is Considered." pp. 243-244.

to Ramanna during a private meeting: "do you want our skulls cracked?"[258] In this clash

between the PMO and the scientists, the PMO's view prevailed. However, for secrecy

reasons, the prime minister and her top advisors did not consult widely within the

government about the potential disruptive effects of sanctions. Likewise, the scientists' had

few institutional means to force decisions on the prime minister and her privy council.

As India verged on nuclear tests in 1982-1983, US spy satellites discovered renewed activity

at the Pokhran test site. In May 1982, Lawrence Eagleburger, the US Undersecretary of State

for Political Affairs confronted India's Foreign Secretary Rasgotra about the impending tests

during the latter's trip to Washington.[259] The cat was thus out of the bag. And yet, top Indian

leaders continued to believe the program's existence could be denied by keeping weapons

development compartmentalized, a condition that stymied coordination across the state's

various agencies. Equally significant, the progress of Pakistan's clandestine procurement

efforts was visible to Indian intelligence agencies and the political leadership. As was the

US's handling of Pakistan with kid gloves.[260] To be sure, Pakistan was a special case during

the 1980s because it rented strategic space to the United States and became a frontline state

in the struggle against the Soviet Union in Afghanistan. In the hierarchy of US foreign policy

and national security interests, this struggle superseded the struggle against nuclear

proliferation.[261]

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[258] Chengappa, "Do You Want Our Skulls Cracked?" p. 260.
[259] Ibid., pp. 255-257.
[260] "Nuclear Backdrop," *Kargil Review Committee Report*, pp. 184-190.
[261] Between 1979 and 1985, the US Congress granted special exemptions to Pakistan from the NNPA; and then in 1985 passed a special amendment, the Pressler Amendment, to allow for continued economic and military aid to Pakistan, so long as the US president could certify to Congress that Pakistan was not in possession of a nuclear device. See, Leonard Spector, "Pakistan," *Going Nuclear*, p. 104; "Context of August 1985: Pressler Amendment Passed, Requiring Yearly Certification That Pakistan Does Not Have Nuclear Weapons,"

During the 1980s the US also discovered a program of substantial Chinese material assistance to Pakistan's nuclear weapons effort. This included the supply of an actual weapon design based on China's fourth nuclear test among other things.[262] However, the Reagan administration proved unwilling or helpless to stem this tide of cooperation. Undoubtedly, US treatment of India was different, especially given New Delhi's close ties with the Soviet Union and its thinly veiled anti-US positions. And yet, the US handling of Pakistani proliferation provides a rough indicator of potential US flexibility in handling proliferation challenges. However, Indian prime ministers in the 1980s took the sequestered view that the US would apply blanket economic and technological sanctions on India, which could in principle cripple India's economy and high-tech sectors. And despite initiating nuclear explosives and ballistic missile programs known to the United States, they kept the programs isolated, their assumption being that opacity and secrecy were equal to deniability.

In any situation of uncertainty, there are what the former US Secretary of Defense Donald Rumsfeld identified as the know knowns, the known unknowns and the unknown unknowns. In assessing the Pakistani nuclear threat, Indian prime ministers' decisions were substantially driven by the known knowns. Among the latter was the very real disparity between the nuclear estates of the two countries. India was the competitor with the greater resource and the greater technological manpower advantage. Its nuclear sector had deep roots and was relatively self-sufficient in the plutonium fuel cycle. India's nuclear estate

History Commons, http://www.historycommons.org/context.jsp?item=a0885pressleramendment (May 2013).
[262] Thomas C. Reed and Danny B. Stillman, "The Fakirs: India, Pakistan and North Korea," *The Nuclear Express: A Political History of the Bomb and its Proliferation*, (Zenith Press, 2009), pp. 252-253.

included uranium mining, milling and fuel rod fabrication facilities, heavy water plants, research and power reactors, and plutonium reprocessing.[263] By this scale of comparison, Pakistan's nuclear estate was miniscule. It possessed only lab-sale spent-fuel reprocessing capabilities to extract weapons-grade plutonium[264] Above all, India had a proven nuclear device, which it had already exploded. Further, with the revival of the nuclear weapons research and development program in 1980s, India was working on advanced boosted-fission designs and miniaturized versions of the fission design tested in 1974.[265] This extant materiality anchored their belief of India's superiority in any nuclear competition vis-à-vis Pakistan. V. S. Arunachalam, the chief of DRDO and scientific advisor to India's defense minister, who became the informal points person for the nuclear project between 1983-1992, summed up the decision-makers point of view to the author:

> "…there was no reason to panic…the panic will come if we didn't know what is a nuclear weapon, if we didn't know how to make it, if we didn't know how to deploy it…what can the panicking do…there is no reason to panic…"[266]

The key challenge in producing a nuclear device is mastering the nuclear fuel cycle to obtain fissile material. Within the nuclear physics and engineering community, the design of a first-generation nuclear device is considered a relatively simpler task. By this measure, India possessed the fissile material. Pakistan did not. Pakistan's original attempt at obtaining plutonium through plans to build natural uranium reactors and import a French plutonium

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[263] Spector, "India," *The New Nuclear Nations*, pp. 106-109.
[264] "Analysis of Six Issues About Nuclear Capabilities Of India, Iraq, Libya And Pakistan," Report Prepared For The Committee On Foreign Relations, United States Senate, *Congressional Research Service,* (January 1982), pp. 1-6, 13-18; Spector, "Pakistan," pp. 126-127.
[265] Perkovich, "More Robust Nuclear Policy Is Considered," pp. 242-243
[266] Arunachalam, interview with author.

reprocessing plant were blocked by the United States in 1976-1977.[267] In response, Pakistan

switched to the uranium enrichment route. Under A.Q. Khan, Pakistan elected for gas

centrifuge technology, an extremely difficult process to master. Centrifuges spin at

extraordinarily high speeds. They require special materials, precision design and exquisite

engineering. They also require well-trained scientific and engineering teams with the formal

and tacit knowledge to operate them.[268] Indian beliefs about the state of Pakistan's advances

were anchored in their own experience with centrifuge enrichment technology. India began

building its own centrifuge enrichment facilities in the early 1970s. However, it only

succeeded in enriching uranium on a pilot scale at BARC by 1985. Construction of a larger

plant to enrich uranium started in the mid-1980s at Rattehalli in Karnataka and the plant

came online in 1990. The Indian enrichment program had significant operational problems

due to "…corrosion and failure of parts" and was beset by delays.[269] The difficulties of

getting this complex technology to work became a cause of skepticism in the minds of top

scientists within India's nuclear establishment about the ability of their Pakistani

counterparts to get the technology to work.

Top Indian civil bureaucrats and their scientific counterparts in the AEC were

contemptuous of Pakistan's nuclear capabilities. For example, in response to Pakistani Prime

Minister Zulfikar Ali Bhutto's famous statement after India's 1974 test that Pakistan would

acquire a matching capability even if Pakistanis had to eat grass, P.N. Haksar who was

formerly Indira Gandhi's Principal Secretary remarked sarcastically:

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[267] Spector, "Pakistan," p. 102.

[268] For details of Pakistan's uranium enrichment effort see, Feroz Hassan Khan, "Mastery of Uranium Enrichment," *Eating Grass: The Makin of the Pakistani Bomb*, (Stanford: Stanford University Press, 2012), pp. 139-161.

[269] M.V. Ramana, "India's Uranium Enrichment Program," *INESAP Information Bulletin,* No. 24, December 2004, *http://www.cised.org/uraniumenrichment_INESAP.pdf* (May 2013).

"If by eating grass one can produce atom bombs, then by now cows and horses would have produced them. But, of course, the people of Pakistan under the great and charismatic leadership to which they are now exposed might produce a bomb on a diet of grass."[270]

Top Indian nuclear scientists similarly expressed contempt towards their Pakistani counterparts. They harbored the biased belief that Pakistan was blustering. A former AEC chairman in the mid-1980s claimed: "We did not take A.Q. Khan seriously. He was a metallurgist. They would not be capable of doing these things."[271] Similarly, Arunachalam, then scientific advisor to India's defense minister, volunteered to the author that he would not have hired A.Q. Khan for any of his labs.[272] Likewise, former AEC Chairman P.K. Iyengar, a central figure in India's 1974 test and the thermonuclear weapon design, informed the author: "I didn't believe it…they could [Pakistan] probably…perhaps build one or more bomb at most…but not more."[273] Dr. M.R. Srinivasan, who served as the Chairman of India's AEC between 1987-1990 while admitting to Pakistani advances in uranium enrichment, summed up the Indian atomic establishment's view of Pakistan's nuclear capacity in the following words:

"Although there are certainly competent scientists and technologists in Pakistan, its nuclear technological base is rather limited, so its scientists have apparently gathered

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[270] Jacques E.C. Hymans, "India's Nuclear U-Turn," *The Psychology of Nuclear Proliferation: Identity, Emotions and Foreign Policy*, (New York: Cambridge University Press, 2006), p. 186.
[271] Quoted in Perkovich, "Nuclear Capabilities Grow," *India's Nuclear Bomb*, p. 275; also see, Ramana, "India's Uranium Enrichment Program."
[272] Arunachalam, interview with author.
[273] Iyengar, Chairman, interview with author.

parts from various international sources…although Pakistan claims parity with India in

nuclear capabilities, there is an order of magnitude difference in the overall capabilities,

not the least in terms of trained personnel and industrial capability."[274]

The Indian nuclear establishment in making assessments of Pakistan's advances lacked

perfect information about its actual state of progress. The known knowns in this case were

that Pakistan had succeeded in acquiring blueprints for a centrifuge-based uranium

enrichment plant from Urenco in the Netherlands; that A. Q. Khan had succeeded in

procuring an entire uranium hexafluoride gas plant from W. Germany; that Pakistani agents

in Europe had purchased special steel known as maraging steel to manufacture centrifuge

cylinders; and that Pakistan had also obtained high-frequency power units to drive the

centrifuges from Western Europe.[275] However, the known unknowns were whether

Pakistani nuclear scientists and engineers had the 'tacit' skills to get the complex technology

up and running.[276] In scientific-industrial processes, tacit hurdles are the hardest ones to

scale. There are limits to the degree to which foreign consultants, suppliers and technology

transfers can bridge the gap between the formal and tacit means of doing things.[277] In the

absence of precise knowledge of the state of Pakistan's tacit skills and knowledge, the Indian

nuclear establishment relied on its own operating experience with centrifuge enrichment to

make inferences about Pakistan. In addition, Indian nuclear scientists at the highest levels

retained connections with their Pakistani counterparts such as the former Chairman of the

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[274] Srinivasan, "The Nuclear Weapon," pp. 278-280.

[275] Ibid., p. 279.

[276] For the classic text on the subject of 'tacit' knowledge, see, Michael Polanyi, *The Tacit Dimension*, (Chicago: University of Chicago Press, 1966).

[277] See, Jacques E.C. Hymans, "Peron's Nuclear Embarrassment," *Achieving Nuclear Ambitions: Scientists, Politicians and Proliferation*, (New York: Cambridge University Press, 2012), pp. 205-220.

Pakistan Atomic Energy Commission (PAEC), Dr. Munir Ahmed Khan. The latter had a bitter falling out with A.Q. Khan whose Engineering Research Labs sidelined PAEC's pursuit of fissile material through the plutonium route.[278] The likes of Munir Ahmed Khan spoke "disparagingly" of A.Q. Khan to their Indian counterparts whom they routinely met on the sidelines of annual IAEA meetings in Vienna.[279] In the process the PAEC inadvertently undermined A.Q. Khan's reputation and underscored the Indian nuclear establishment's skepticism of Pakistani claims.

In comparison, Indian intelligence agencies dutifully reported the advances in the Pakistani nuclear weapons program to the PMO. In early 1981 for example, Indian intelligence informed the PMO that Pakistan would have sufficient weapons-grade uranium by July-November that year; and that Islamabad had initiated preparations for an underground test explosion in the Rashkoh mountains in Baluchistan.[280] In 1982, Indian intelligence agencies estimated that Pakistan very likely possessed weapons-grade fissile material for a bomb "core or two."[281] Indian intelligence reports duly reported Pakistan's purchase of krytron switches used to deliver pulsed electric charges in a nuclear device. They also tracked Pakistan's purchase of X-ray machines used for high-speed flash photography. The latter is used for testing the non-nuclear trigger assembly of a nuclear device. The also noted Pakistan's purchase of software for simulated implosion test analysis on computers.[282] By the mid-1980s, all signals suggested that Pakistan was developing a nuclear device. Based on these inputs, Indian intelligence chiefs in the mid-1980s recommended a counter Indian

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[278] Khan, "Mastery of Uranium Enrichment," pp. 147-150.
[279] Srinivasan, "The Nuclear Weapon," pp. 279-280.
[280] Record of Discussion with K. Santhanam, "Nuclear Backdrop," *Kargil Review Committee Report,* pp. 187-188.
[281] Ibid.
[282] "Nuclear Backdrop," *Kargil Review Committee Report*, pp. 189-190.

weaponization program to Prime Minister Rajiv Gandhi.[283] However, Gandhi was "skeptical," according to K. Subrahmanyam, who sat in on the 'Policy Planning Group' in 1985. The prime minister "…asked a lot of questions."[284] Similarly, former AEC chairman P.K. Iyengar affirmed Gandhi's skepticism with the raw intelligence. Gandhi, according to Iyengar, was more confident about what was told him by the nuclear establishment. "He asked me how I could or could not be confident that the Pakistanis were enriching uranium…I explained him how. And he then believed me."[285]

Like their intelligence counterparts, India's top military leaders also urged the prime ministers nuclear haste. In the early 1980s, the army chief General Rao led that charge circumventing the civil-military divide and the defense ministry's normal channels of communications with the PMO.[286] His successor, General Sundarji, lobbied for nuclear weapons even more vociferously, both in his official capacity as army chief and through his close personal relationship with Arun Singh, who was Rajiv Gandhi's confidante and managed the defense ministry for the prime minister as minister of state.[287] The Indian air force did not lobby for nuclear weapons directly. However, after Israel's destruction of Iraq's Osiraq reactor in 1981, its operations staff prepared an internal study on similar options against Pakistan's Kahuta uranium enrichment plant.[288] The latter were allegedly discussed

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[283] Subrahmanyam, interview (2) with author.
[284] Ibid.
[285] Iyengar, interview with author.
[286] Chengappa, "Do You Want Our Skulls Cracked?" pp. 255, 260.
[287] Deshmukh, "Economic and Defense Matters," pp. 163-166; K. Subrahmanyam, "Introduction," in K. Sundarji, *Vision 2100: A Strategy for the Twenty-First Century,* (New Delhi: Konark Publishers Ltd., 2003), pp. xvii-xxxii.
[288] According to the Indian Air Force's director of air operations at the time: "In the wake of the Israeli attack on Osiraq, the IAF's Offense Operations Directorate drew up plans…I was its director at the time. But this was contingency planning...just a four-page plan. I do not know if it went up to the Air Chief of Staff. I don't know whether Air Headquarters and the

and rejected by the PMO.[289] Concerns also grew within India's military that Pakistan had begun supporting insurgents in India's Punjab confident in the belief that its emerging nuclear arsenal had immunized it against a potential Indian conventional counter response. In 1986, the Indian army conducted *Operation Brasstacks*, its largest war games in history to test Sundarji's technical and organizational reforms for mechanized maneuver warfare in the Pakistan theater.[290] The exercise almost spun out of control and triggered war as nervous Pakistani leaders counter-mobilized and threatened undefended Indian territory in the Punjab.[291] The bulk of the evidence suggests that pre-emptive war was not India's intent. However, the exercise was certainly regarded as a show of force; a means to coerce Pakistan into terminating support for the insurgency in the Punjab.[292] At the height of the crisis, when Rajiv Gandhi toyed with the idea of initiating war against Pakistan, General Sundarji counseled the prime minister to do just that in what he urged was India's last realistic chance to destroy Pakistan's nuclear weapons program in the bud.[293]

The above evidence shows that there was a diversity of opinions within the Indian government during the1980s about the state of Pakistan's nuclear progress and what India

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political leadership considered attacks on Kahuta in 1984. They may have, but I do not know about it. And I did not ask the concerned individuals about it. It would not have been difficult to destroy Kahuta, the surface structures; destruction of underground structures would have required bunker penetrating bombs…for which we could have turned to the Israelis." Air Commodore Jasjit Singh, Director, Center for Airpower Studies, interview with author, May 6, 2009, New Delhi (India).

[289] Scott D. Sagan, "Indian and Pakistani Nuclear Weapons: For Better or Worse?" in Scott D. Sagan and Kenneth Waltz, *The Spread of Nuclear Weapons: A Debate Renewed*, (New York: W.W. Norton Company, 2003), p. 93.

[290] Kanti P. Bajpai, P.R. Chari, Pervaiz Iqbal Cheema, Stephen P. Cohen & Sumit Ganguly, *Brasstacks and Beyond: Perception and Management of Crisis in South Asia,* "India and the Initiation of the Crisis," pp. 27-33.

[291] Bajpai, Chari et. al., "Pakistan: Response and Escalation," *Brasstacks and Beyond,* pp. 49-60.

[292] Perkovich, "Nuclear Capabilities Grow," p. 278.

[293] Ibid., p. 280.

ought to do about it. Decision-makers in the PMO were aware of nuclear developments across the border but uncertain of the precise nature of the Pakistani threat. They were over-cautious in determining an Indian counter response because of their biased view of the extreme reaction it might induce from the United States. The PMO's extreme caution was also reinforced by its almost exclusive reliance on the atomic energy establishment for assessments of Pakistan's nuclear progress. Although leading Indian nuclear scientists favored faster progress on nuclear weapons development, they also harbored deep skepticism about Pakistan's claims to achieving nuclear weapons capability. Their skepticism was not based on incontrovertible data. It drew on the wellsprings of biases fed by India's difficulties with mastering the gas centrifuge uranium enrichment process. In contrast, Indian intelligence and military chiefs held more alarmist views of Pakistan's nuclear quest and its consequences for India. Once again, their views did not rest on certainty. However, as James Surowiecki explains in the *Wisdom of Crowds*, crowds have a lower tendency for judgment errors in the face of uncertainty because their independent errors cancel each other out, a phenomenon less likely in decisions by individuals and closed groups. The key to better prediction amidst imperfect information is independence, diversity of opinion and a way of aggregating diverse opinions.[294] In India, however, secrecy and the sequestered process of decision-making cut off the oxygen of crowd sourcing from within the government, which amplified the biases of the decision-makers.

The big unknown unknown before India in the 1980s was whether Pakistani nuclear scientists had acquired the tacit knowledge to work the Kahuta uranium enrichment plant and build nuclear weapons. Unbeknownst to the Indian nuclear weapons establishment and

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[294] James Surowiecki, "Part I," *The Wisdom of Crowds,* (New York: Doubleday, 2004), pp. 1-142.

its intelligence agencies was the extent of the secret nuclear cooperation between Pakistan and China. For example, Indian prime ministers were briefed on reports in the early and mid-1980s that China had likely shared a nuclear weapon design with Pakistan. However, Indian intelligence agencies were only able to confirm that only in 1988.[295] New evidence from US intelligence sources and US nuclear scientists with extensive contacts within the Chinese nuclear weapons complex suggest that China cooperated with Pakistan extensively during the 1980s. The nature of that cooperation included: training Pakistani scientists in nuclear weapons design starting in 1982-83; the transfer of the CHIC-4 implosion type enriched uranium warhead; assistance in the design of explosive lenses for an implosion device; the transfer of a neutron initiator for the device; and ultimately the conducting of an actual nuclear test (Event 35) for Pakistan at China's Lop Nur test site on May 26, 1990.[296] Throughout the 1980s, US intelligence sources tracked the presence of Chinese nuclear scientists and engineers at the Kahuta uranium enrichment plant as well as the Wah Cantonment complex near Islamabad. Similarly, Pakistani nuclear scientists and technicians were constant fixtures in sensitive nuclear weapons related facilities in China.[297] Thomas Reed and Danny Stillman[298] believe that Event 35 in 1990 was:

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[295] "Nuclear Backdrop," *Kargil Review Committee Report*, p. 188.

[296] Reed and Stillman, "The Fakirs: India, Pakistan and North Korea," pp. 252-253.

[297] Jeffrey T. Richelson, "Rogues," *Spying On The Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*, (New York: W.W. Norton Company, 2006), p. 343.

[298] Thomas C. Reed is a veteran of the Lawrence Livermore National Labs and has served as Secretary of the US Air Force. Danny B. Stillman was a former director of intelligence at Los Alamos National Labs. See, "The Hidden Travels of the Bomb," *New York Times,* December 8, 2008, http://www.nytimes.com/2008/12/09/science/09bomb.html?pagewanted=all (April, 2013).

"…a fairly crude but reliable enriched uranium design, unboosted but using a Chinese

neutron initiator scheme, all in a configuration that had been successfully cold tested

within Pakistan during the 1980s."[299]

Historians of Pakistan's nuclear weapons program such as Feroz Khan have downplayed the

scope of Chinese cooperation.[300] However, unlike the US nuclear labs and intelligence

agencies, Khan has provided no hard evidence to back this claim. However, even Khan

admits that China transferred enriched uranium sufficient for two nuclear bombs to Pakistan

in 1981.[301]

Clearly, Pakistan was much further ahead on the nuclear learning curve than the Indian

nuclear establishment and PMO knew or had imagined.[302]

Secrecy, Weak Inter-Agent Competition and Principal-Agent Problems

Bias in sequestered institutional settings, as the evidence above shows, expands the scope for

decision-making errors. The other negative consequence of sequestration and low

information turnover is the very real constraint on political leaders' ability to police the

activity of their subordinates (agents) within the state. In proliferating states, external opacity

is not only useful to protect the state's autonomy for action from pressure by adversarial

states. Equally significant, domestic opacity also serves to protect decision-makers'

autonomy of action within the state, lest they be pushed to take up agendas advanced by

their agents, which might not be in their best interests and by extension that of the state's.

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[299] Reed and Stillman, "The Fakirs: India, Pakistan and North Korea," p. 253.
[300] Khan, "Building the Bomb," *Eating Grass*, p. 175.
[301] Ibid., pp. 188, 190.
[302] Ibid.

Leaders do this by compartmentalizing programs and information concerning them and limiting cooperation between agencies and their agents. However, in any organizational setting, transparency, high-information exchange and inter-agent competition are the keys to leaders' obtaining credible information about programmatic choices. The downside of a regime of information scarcity is poor agent management and leaders commitment to public policy choices without fully understanding the risks involved in making them.

In the rest of this chapter, I demonstrate the logic of this argument by comparing principal-agent problems in India's nuclear power sector in the late 1960s under conditions of information monopoly and their subsequent mitigation through inter-agent competition. I compare the course correction in India's nuclear power program with the 1974 nuclear test. I present evidence to show that there was a serious dispute about the yield of the 1974 fission device within BARC. However, that information never percolated up to the PMO due to the lack of inter-agent /agency competition. Next, I show that during the 1980s internal opacity and lack of alternative sources of information led prime ministers to harbor an unduly optimistic assessment of India's capacity for nuclear breakout, both in the context of the steady supply of fissile material as well as the potential of transforming lab-stage nuclear devices into deliverable weapon. Equally significant, information asymmetries between political leaders and their technical advisors produced less than optimal choices in India's ballistic missile program in this period. The net consequence was that the missiles developed represented the missile development agency's organizational interests and not those of users' potential for deployment and use. Finally, the absence of agent monitoring between the nuclear and air force teams had highly negative consequences for resolving the challenges of air delivery.

The history of India's civilian nuclear power sector provides a clear example of how low information turnover and the lack of inter-agent competition produces adverse selection. It also serves as an example of how the introduction of internal policing through agent competition produces palliative effects. The institutional legacy of India's nuclear estate is one of secrecy for reasons that have a lot to do with its defense implications, the desire to place atomic energy outside the calcified purview of India's bureaucracy, and the close personal friendship between Prime Minister Nehru and the founding chairman of the DAE, Dr. Homi Bhabha.[303] The AEC board exercised oversight over the entire atomic energy sector and made all the critical programmatic choices. On the board sat two "technical" members, both representatives of the DAE. They alone had the competence to appraise the technical quality of programmatic choices. Other members on the board included the prime minister's principal secretary, the cabinet secretary and the finance member. These non-DAE members had no technical competence and they concerned themselves with procedural, financial and organizational matters and generally approved decisions that were subsequently rubber stamped by the PMO and approved by the cabinet.[304]

Critical examples of programmatic choices included the decision to purchase different reactor types from the United States and Canada when commercial reactor operations were largely unproven. Other prominent and controversial examples include the famous Sarabhai Profile (1970), which planned on quintupling India's nuclear power-generation capacity from 600MW in the early 1970s to 2800MW by 1980. The Sarabhai Profile also outlined ambitious

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[303] Abraham, "Creating the Indian Atomic Energy Commission," *The Making of the Indian Atomic Bomb*, pp. 34-68.
[304] Parthasarathi, "In the Department of Atomic Energy (1967-70)," p. 20.

plans to double the capacity of power reactors from 200-230MW to 500MW without accounting for India's industrial capacity for reactor construction, natural uranium mining and fuel fabrication, heavy water production, or the ability of the electrical grid to uptake the power generated.[305] The DAE also artificially lowered the cost of nuclear generation to make it competitive with alternative sources of energy. It achieved this by accounting sleights of hand: by deliberately not factoring for the cost of heavy water , waste disposal, or the price of dismantling the reactors at the end of their life cycle. More alarmingly, the DAE hid the problems of reactor operations such as heavy water leaks, radioactive contamination, reactor damage, and fuel-rod damage. The DAE also did not appraise the PMO about other problems afflicting the nuclear estate including the poor performance of the sensitive plutonium reprocessing plant.[306]

By the early 1970s, as Indira Gandhi consolidated power, the PMO expanded its institutional reach and acquired personnel to monitor the DAE. Ashok Parathasarathi who served as scientific advisor to prime minister narrates the saga of agent competition between him and the AEC chairman Vikram Sarabhai. As a consequence of the independent inputs from Parthasarathi, the PMO rejected the Sarabhai Profile after first having approved it, split the DAE and space department into two separate agencies, gave Sarabhai charge of the latter and removed him as head of the atomic energy department. Plans for generating nuclear power were subsequently revised downward. The plan for building 500MW reactors was also dropped. Due to Parthasarathi's independent monitoring, the PMO was also made cognizant that the costing estimates for nuclear power were rigged.[307] However, the prime minister's

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[305] Parthasarathi, "Atomic Energy," pp. 99-109.
[306] Ibid., pp. 17-18, 114-115, 116-117, 118,
[307] Ibid., pp. 118-124.

principal secretary at the time, P.N. Haksar, decided to ignore these rigged estimates, because he felt "…there were larger objectives to our [India's] nuclear program than nuclear power and those objectives cannot be compromised at any cost."[308]

In the case of case of the 1974 nuclear test, however, there was no inter-agent competition. There were only three points of contact between the PMO and the nuclear team at BARC: Homi Sethna, Raja Ramanna and P.K. Iyengar. During Mrs. Gandhi's visit to Trombay in 1972 when the decision to build the device was approved, the four agreed not to commit anything to paper, especially from the PMO. [309] After the test, AEC Chairman Homi Sethna publicly announced the yield of the device between 10-15kt. Initial analyses of the device's yield were based on seismic measurements and not on post-shot analysis of the yield debris from the explosion crater. Indian scientists Raja Ramanna and P. Chidambaram subsequently presented a scientific paper at the IAEA in Vienna, in which they claimed the implosion device had a yield at 12kt. However, their estimate too was calculated on the basis of seismic verification, not on post-shot analysis of the crater's debris. BARC subsequently did undertake a post-shot analysis.[310] And the internal findings of its radiochemistry division placed the yield far lower at 5kt.[311]

A senior official who served in BARC's radiochemistry division at the time and participated in that analysis revealed to the author in 2010:

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[308] Ibid., p. 124.
[309] Iyengar, interview with author.
[310] Perkovich, "India Explodes a 'Peaceful' Nuclear Device," *India's Nuclear Bomb,* pp. 181-183.
[311] Iyengar, interview with author.

"Now R. Chidambaram was there at Pokhran I…I established mass spectrometry as a method of measurement and analysis. And I did all the isotopic measurements. And I did isotopic measurements on the Pokhran debris. And my yield was… much lower…and they threw the book at me…and classified my report… so I questioned that. I became unacceptable after that. They started looking at me with suspicion. I didn't say anything. I didn't tell anybody. I didn't go to the newspaper. I gave an internal report saying that your calculated values are not correct; it is higher than what I am getting."[312]

However, former AEC Chairman P. K. Iyengar discounted the radiochemistry division's report on grounds that the method of sampling the debris had a 40-50 percent chance of error. Iyengar reported to Ramanna that the yield was in the ballpark of 10-12kt.[313] Subsequently, Iyengar lowered his estimate of the yield to 8-10kt.[314] However, Ramanna, who served as Chairman of the AEC during 1983-1986 continued to insist even as late as 1991, when he published his autobiography, that the yield of the Pokhran I device was between 12-15kt.[315] The scientific controversy on the Pokhran I yield remained buried inside BARC. It resurfaced after 1998 when rumors arose that the thermonuclear device and its boosted fission primary, which the DAE claimed were the highlight of the second round of tests, had underperformed. Indirect evidence of the Pokhran I device's failure is available in a recently declassified State Department cable drafted by Steve Ghitelman in January 1996. Written in the context of impending Indian nuclear tests, the cable states:

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[312] Senior BARC official, non-attributable interview with author, July 7, 2010, Bangalore, (India).
[313] Iyengar, interview with author.
[314] Ibid.
[315] Ramanna, "Pokhran," *Years of Pilgrimage*, p. 91.

"Technicians want to test…the activity brings the site [Pokhran test site] to a

heightened state of readiness in the event Rao [Prime Minister Narasimha Rao] makes a

decision to test, but it says nothing about his decision to do so. Rao's scientists may be

pushing for one or more tests of India's unproven nuclear designs, which need

significant reworking after the near-failure of the 1974 test."[316]

In 1996, former AEC Chairman Sethna admitted to George Perkovich that the

radiochemical analysis, the gold standard for assessing yield in the nuclear test business, had

shown a yield lower than the one publicly announced. When Perkovich questioned Iyengar

why the results of the radiochemical analysis had never been published, the latter responded:

"what does it matter if it was 8 or 12kt?"[317]

The significance of this controversy is not about the sociology of settling scientific

controversies and method. It has real-world implications for the political and military

leadership. In the absence of any oversight authority and inter-agent/agency competition

and only one-way channels of information on sensitive nuclear weapon related secrets, the

prime ministers and the Indian government were in the dark that the Pokhran I device, the

basis of subsequent assumptions for India's nuclear breakout capability, had underperformed

and was technically unreliable.

Through the 1980s and 1990s, succeeding AEC chairmen and BARC had a monopoly on

nuclear weapons-related inputs to the PMO, with literally no outside scrutiny. Former AEC

Chairman M.R. Srinivasan admitted as much to the author in an interview with the caveat

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[316] US Department of State Case No. M-2009-00895, Doc No. C17601478, August 15, 2012.
[317] Perkovich, "India Explodes a 'Peaceful' Nuclear Device," p. 182.

that prime ministers on occasion also consulted some of their close bureaucratic advisors and senior cabinet colleagues on *political* decisions surrounding nuclearization.[318] Another AEC Chairman, P.K. Iyengar downplayed concerns about the lack of agent competition in questions of science and technical expertise and argued that:

"…we should stop looking at the issue from an American point of view. During the Manhattan project, the government [US] trusted the scientists. In one instance, General Groves attempting oversight by pointing out a mathematical error during a meeting with scientists. However, the scientists told Groves that they were concerned with the physics of the issue and not necessarily strict mathematical accuracy. In the case of Manhattan project, the US governments had no proof that the Hiroshima device would work…but the president trusted the scientists.

Most political systems at inception of great scientific and technical projects rely on trust. Institutions follow at later stages when projects mature. In the Apollo program…Kennedy had no credible means for assessing if the mission to place man on the moon was indeed possible. However, he and his aides proceeded on the basis of trust.

In India's case as well…there is a great tradition of trust between prime ministers and senior scientists….embodied in the rapport shared by Nehru and Bhabha…and thereafter by leaders of the DAE…American notions of institutions, laws, and regulations are misplaced…largely because such mechanisms are a weak substitute for trust…and actually indicate the absence of trust in society.

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[318] Srinivasan, interview with author.

It was…trust which operated between Indira Gandhi and the top BARC hierarchy

during the 1974 test…and also throughout the decades of the 1980s and 1990s when

nuclear weapons development at BARC was kept secret from the prying eyes of foreign

powers."

Indeed, based on private assurances from the scientists, Prime Minister Rajiv Gandhi

claimed publicly in 1985 that if India were to decide on becoming a nuclear weapons power

it would only take a few weeks or a few months to do so. Or as the scientists put it to the

prime minister, "…if the government should ever want this capability you shall have it."[319]

These assurances were based on the work on the weapon program in the lab and not the real

world of production, deployment and use. For example, until 1985 India had no consistent

source of weapons-grade plutonium. In the past, India had used the Canadian supplied

CIRUS reactor for generating spent fuel, which was then reprocessed to extract weapons-

grade plutonium. Prior to the 1974 test, the reactor used US-supplied heavy water, which is

one reason why India dubbed the 1974 test a PNE. India could not have legally conducted

nuclear weapon explosions using plutonium fuel from CIRUS because of the peaceful

assurances it had made to the US and Canada.[320] What India needed was an indigenous

research reactor dedicated to the production of weapons-grade plutonium. The construction

of a scaled-up indigenous version of the CIRUS reactor was made a top priority starting

1981. This reactor, the 100MW R-5 or *Dhruva*, went critical in 1985.[321] However, the reactor

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[319] Perkovich, "Nuclear Capabilities Grow," p. 268

[320] "India's Nuclear Program – Energy and Weapons: An Intelligence Assessment,"
Directorate of Intelligence: Central Intelligence Agency, July 1982, SW 8210056C/SC 00406/82, p. iv,
approved for release, July 19, 2010.

[321] Former AEC Chairman Raja Ramanna claimed in 1991 that the *Dhruva* went critical in
1983 and functioned "…without any trouble…at its maximum capacity." His successor M.R.
Srinivasan pushed the date to 1985 and admitted to vibrations-induced fuel damage. Former

shut down as soon as it started. A fuel leak caused radioactive contamination in the coolant system. The problem was ultimately traced to vibrations generated from the coolant system, which resonated with the frequency of the core, causing the fuel rod damage and leaks. The reactor was restarted in December 1986 and operated at one fourth of its rated capacity until 1988 when it achieved full power.[322] What this means is that compared to Pakistan, which achieved the capacity to enrich uranium to weapons grade in 1985,[323] India's capacity for a sustained weaponization program was severely constrained until 1988.

Further, in the absence of multiple agent inputs, particularly from the military, Gandhi was unaware of the challenges of fitting the lab weapon into a pod for air delivery. Attempts to sling the first generation weapon under the air force's Jaguar had already failed because of problems emanating from the weapon's large diameter and low ground clearance of the aircraft.[324] The Jaguar, according to senior air force officers involved with the aircraft, could in theory have served as an ideal delivery platform. In the case of the Jaguar, the air force had succeeded in rewriting the software code for the aircraft's electronic warfare and navigational attack systems. That process took about "500 flights to clear…and five to six years," according to a senior air force officer involved in the program.[325] This was not the case with Dassault's Mirage 2000, which the Indian Air Force acquired from France in the

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Indian Cabinet Secretary Deshmukh admitted that a consistent supply of plutonium became available to the Indian government in 1988 after *Dhruva* went critical. See, Ramanna, "Gangotri and Gomukh," p. 111; Srinivasan, "The Nuclear Weapon," p. 272; Chengappa, "The House Is On Fire," p. 332.

[322] David Albright, "India's Military Plutonium Inventory, End 2004," *ISIS,* May 7, 2005, http://isis-online.org/uploads/isis-reports/documents/india_military_plutonium.pdf.

[323] Reed and Stillman, "The Fakirs: India, Pakistan and North Korea," p. 251.

[324] Chengappa, "Arsenal For The Gods," *Weapons of Peace,* p. 285.

[325] Deputy Air Chief of Staff 'G', non-attributable interview with author, February 9, 2010, Gurgaon, India.

mid-1980s. However, due to the lack of inter-agency sharing, the weapon that came out of the lab was unfit for delivery by the Jaguar.

The design of a subsequent delivery casing for the Mirage proceeded in secrecy at the Terminal Ballistics Research Laboratory and Armament Research & Development Establishment without any timelines. As one of the members in the design team put it: "…our bosses seemed satisfied with whatever pace we set," until the weaponization decision in 1989 when the tenor changed to: "…the house is on fire. All this should have been ready yesterday. Now rush, rush!"[326] Another senior air fore officer complained about the DRDO's "amateurish" way of designing the weapon without interaction with the user service. As he put it, "…DRDO underestimates the intellectual, technological, and managerial challenge of building complex systems, or deliberately underplays the challenge of the tasks to game the system…knowing full well that the weapon system would never be delivered on time…but that the system could be gamed indefinitely."[327] Recalling his interaction with Arunachalam, he went on: "…Arunachalam had the habit of proposing accelerated time lines for weapon development that were divorced from reality." In the case of air delivered nuclear bombs, "the design of reliable height burst fuses is extraordinarily difficult…and such fuses are critical for accurate airburst." Recalling the DRDO's failures in the design of conventional runway denial and cluster bombs, the air force officer disclosed that he ordered DRDO to "halt tests and stop wasting the air force's money."[328] In the absence of institutional representation from the air force, decision-makers in the PMO were unaware of the potential of such technical and organizational minutiae to delay the program.

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[326] Chengappa, "The House Is On Fire," p. 336.
[327] Deputy Chief of Air Staff 'N', non-attributable interview with author.
[328] Ibid.

The final exhibit of the consequences of weak inter-agent/agency competition comes from the case of India's ballistic missile program in the 1980s. The short-range Prithvi missile that emerged out of it, and which alone could conceivably have served as a nuclear delivery vehicle, was explicitly designed around the DRDO's organizational legacy, which was an attempt to reverse engineer the Soviet SA-2 surface-to-air missile's liquid fuel engine.[329] Classified as the 'Devil' program in the 1970s, no operational weapon system had emerged out of it, leaving the agency demoralized. The DRDO therefore tried to rebuild its missile lab's morale by resuscitating the Devil program in the form of the short-range Prithvi. The political leadership signed off on the program without understanding its operational viability.[330] The missile that emerged out of the program flew successfully. However, its toxic fuel, corrosion problems associated with fuel-storage, long fueling routine before launch, short-range and large logistics train made it unsuitable as a nuclear weapon carrier of choice.[331]

Conclusion

The central focus of this chapter is the political management of national security risk. Its key arguments are that leaders require epistemic actors and well-developed knowledge markets to arrive at sophisticated understandings of the state's internal and external realities.

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[329] Chengappa, "The Devil's Workshop," *Weapons of Peace*, pp. 164-174.

[330] Chengappa, "Arsenal For The Gods," *Weapons of Peace,* pp. 276-279; A.P.J. Abdul Kalam with Arun Tiwari, "Propitiation," *Wings of Fire*, (Hyderabad: Universities Press, 1999), pp. 114-117.

[331] Zian Mian, A.H. Nayyar and M.V. Ramana, "Bringing the Prithvi Down to Earth: The Capabilities and Potential Effectiveness of India's Prithvi Missile," *Science & Global Security,* 7, no.3, (1998), pp. 333-360.

Likewise, processes are important because they serve as "time lengthening" mechanisms. The latter are necessary to subject raw information to the scrutiny of multiple eyes; to cancel out biases and errors and produce more accurate forecasts in environments characterized by imperfect information. Secrecy and stove-piping information through one-way channels are poor means for political principals to manage their bureaucratic agents. Evidence presented in this chapter supports the claim that India's nuclear restraint during the 1980s in the face of a looming Pakistani threat was not the consequence of the normative beliefs of decision-makers in Gandhian-Nehruvian moralism. Nor was it a cultural bias stemming from beliefs in the symbolic aspects of nuclear weaponry. The restraint was a subjective decision rooted in the decision-makers' understanding of risk, exaggerated at one end and underestimated at the other. Weak institutional processes and secrecy also attenuated Indian leaders' capacity to actualize instituted options into a viable strategy. The end result was a strategy of muddling through, one that became perceived on the outside as a deliberate and rational strategy of normative restraint.

CHAPTER FOUR

OF NUCLEAR POSSESSOR STATES & NUCLEAR WEAPON POWERS: LIFTING INDIA'S VEIL OF NUCLEAR AMBIGUITY (1989-1998)

In the spring of 1989, Indian Prime Minister Rajiv Gandhi finally decided to follow Pakistan's lead and authorized the building of air deliverable nuclear weapons. Although this decision was a highly classified secret, by the early 1990s it was generally assumed that India and Pakistan were *de facto* nuclear weapon powers, by which is meant the technical capability to assemble and deploy nuclear weapons and the organizational capacity to use them instrumentally.

In his history of the Indian nuclear weapons program, George Perkovich cited evidence that during 1988-1990, India readied at least "at least two dozen nuclear weapons for quick assembly and dispersal to airbases for delivery by aircraft for retaliatory attacks against Pakistan."[332] Writing in 1992, George Quester downplayed the challenges of "weaponization" and declared the issue of nuclear delivery a minor one.[333] Both Perkovich and Quester claimed that whatever nuclear weapons India possessed at the time were readily deliverable via its fleet of Mirage, Jaguar and MiG combat aircraft.[334] Carnegie Endowment's

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[332] Perkovich, "The Nuclear Threat Grows Amid Political Uncertainty," *India's Nuclear Bomb*, p. 293.
[333] George H. Quester, "Nuclear Pakistan and Nuclear India: Stable Deterrent or Proliferation Challenge," *Strategic Studies Institute,* (Carlisle: US Army War College, 1992), pp. 5, 7-10.
[334] Perkovich, "The Nuclear Threat Grows Amid Political Uncertainty," p. 295.

Leonard Spector similarly echoed these claims independently.[335] Summing up the prevailing

view of the state of Indian nuclear capabilities at the time, Steve Coll of the *Washington Post*

reported in 1991 that, "while the exact status of the military nuclear programs in India and

Pakistan is being kept secret, US officials believe both countries have acquired the ability to

produce and deploy quickly a small number of nuclear weapons…both countries possess

sophisticated fighter aircraft that could conceivably penetrate air defenses while carrying one

or more nuclear bombs."[336]

These prevailing views were reinforced by US government officials who never tired in public

of pointing to the immediacy and severity of the proliferation threat in South Asia. For

example, during the 1989-90 Indo-Pakistani crisis over Kashmir,[337] a senior US defense

official suggested that "If readiness is measured on a scale of one to 10 and the Indians are

normally at six, they have now moved to nine."[338] US intelligence sources estimated that

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[335] Leonard Spector with Jacqueline R. Smith, "India," *Nuclear Ambitions: The Spread of Nuclear Weapons 1989-1990,* (Boulder: Westview Press, 1990), p. 79.

[336] Steve Coll, "South Asia Retains Its Nuclear Option: India and Pakistan Post Dual Risk as Potential Flash Points," *Washington Post* (Washington, D.C.), September 30, 1991, p. A1.

[337] The Kashmir Crisis between India and Pakistan erupted during the winter of 1989 and dissipated by the end of spring 1990. The trigger for the crisis was a domestic insurgency in Indian-administered Kashmir, which broke out in the winter of 1989. Pakistani military and intelligence services gave material and moral support to Kashmiri insurgents on the model of the Afghan insurgency against the Soviets in the 1980s, though on a far lesser scale. In January 1990, the Pakistani foreign minister Shahabzada Yakub Khan traveled to Delhi and delivered what Indian political leaders perceived as a veiled nuclear threat. The crisis was ultimately defused with the help of American diplomatic intervention. But during the crisis, the US believed that Pakistan may have assembled and possibly deployed a nuclear weapon. See, *From Surprise to Reckoning: The Kargil Review Committee Report*, pp. 65, 204; P.R. Chari, Pervaiz Iqbal Cheema, and Stephen P. Cohen, *The Compound Crisis of 1990: Perception, Politics and Insecurity,* (London: Routledge, 2003); Seymour M. Hersh, "On the Nuclear Edge," *New Yorker,* (March 29, 1993), http://www.newyorker.com/archive/1993/03/29/1993_03_29_056_TNY_CARDS_000363214, (July 2012); Robert Burrows and Robert Winderm, *Critical Mass: The Dangerous Race for Superweapons in a Fragmenting World,* (New York: Simon & Schuster, 1994).

[338] James Adams, "Pakistan Nuclear War Threat," *Sunday Times* (London), May 27, 1990, p. 1.

India was capable of building nuclear weapons within a matter of days and that weapons could be delivered by combat aircraft, a point reinforced by Lynn Davis, the US Undersecretary of State for International Security Affairs.[339] In a February 1993 hearing on proliferation threats before the US Senate Committee on Governmental Affairs, then CIA Director R. James Woolsey stated: "The arms race between India and Pakistan poses perhaps the most probable prospect for the future use of weapons mass destruction, including nuclear weapons. Both nations have nuclear weapons development programs and could, on short notice, assemble nuclear weapons…advanced aircraft are often the delivery system of choice for weapons of mass destruction, and they are now commonplace among proliferating countries…the aircraft available to these countries are fully capable of delivering nuclear weapons…"[340]

However, there was a broad consensus among both US officials and non-governmental experts that neither India nor Pakistan maintained assembled weapons that were immediately employable. Between 1988-1998, the two common conceptual frames used to describe Indian and Pakistani nuclear postures were "non-weaponized" and "recessed" deterrence. Although these frames of reference were often used interchangeably, they pack different meanings. This is why it is important to distinguish between them. George Perkovich popularized the term "non-weaponized deterrence" in 1993 and advanced it as a policy alternative that India and Pakistan could conceivably use as a bridge between the two extremes of fully deployed nuclear arsenals and nuclear rollback. Perkovich's "third" way

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[339] Michael R. Gordon, "South Asian Lands Pressed on Nuclear Arms," *New York Times* (New York)*,* March 23, 1994, p. 5.
[340] "Proliferation Threats of the 1990s," *Hearing before the Committee on Governmental Affairs: United States Senate*, February 24, 1993 (Washington, DC: US Government Printing Office, 1993), pp. 14-15.

drew the line at building nuclear weapons and deploying ballistic missiles.[341] Under it,

deterrence would stem from the mere existence of nuclear capability and the ability of either

country to build nuclear weapons quickly. It would allow both countries to reap the security

benefits of nuclear weapons without running afoul of the US-led international

nonproliferation community.[342]

However, Perkovich conceded that "only a small minority of tight knit elites" in both

countries had knowledge of the actual nuclear state of affairs and their views on "non-

weaponized deterrence" were "difficult to ascertain."[343] Furthermore, Perkovich's non-

weaponized deterrence proposal was exploratory and largely aspirational. However, by 1996-

1997, scholars such as Rosalind Reynolds baldly asserted, with little evidence, that emerging

nuclear weapon powers were tacit adherents to the regime of non-weaponized deterrence.[344]

India, Reynolds claimed, abided by the regime out of normative concerns in order to

safeguard its reputation as a disarmament advocate and remain a good international citizen.

Reynolds also expanded Perkovich's non-weaponized schema to include the absence of

strategic planning involving nuclear weapons and their integration into the military. She

viewed the lack of operational planning as evidence that emerging nuclear powers such as

India and Pakistan regarded nuclear weapons as diplomatic and not military assets.

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[341] George Perkovich, "A Nuclear Third Way In South Asia," *Foreign Policy*, No. 91 (Summer 1993), pp. 96-98.
[342] Ibid., pp. 102-104.
[343] Ibid., p. 90.
[344] Rosalind Reynolds, "The Diplomatic Role of Non-Weaponized Programs," *INSS Occasional Paper 7*, Proliferation Series, USAF Institute for National Security Studies, (January 1996), https://www.fas.org/irp/threat/ocp7.htm (November 2012).

In contrast, Singh's notion of "recessed deterrence" assumed that India possessed all the elements of a working nuclear arsenal: warheads, delivery systems and operational routines. However, all the working elements of the arsenal were withheld from operational readiness. Hence, the characterization "recessed." More important, in his conceptual frame, this lack of operational readiness was not the consequence of India's normative commitment to nonproliferation. Rather, it stemmed from Indian decision-makers' concerns for strategic stability. That said, the condition of the arsenal, from its normally unconstituted state to an operationally deployed form, was contingent on threat assessments. In other words, the arsenal's operational readiness would parallel the rise in threat levels.[345] However, the crucial difference between "recessed" and "non-weaponized" deterrence frameworks was their presumed causal driver. In non-weaponized deterrence, the driver was deference to nonproliferation norms. In recessed deterrence, the driver was strategic stability.[346]

In this chapter, I present evidence to show that most assumptions about the state of India's nuclear capabilities in the decade prior to the 1998 nuclear tests were wrong. India did not possess deliverable nuclear weapons until at least 1994-1995. [347] Although India elected to build weaponized nuclear devices in 1989, the process of integrating them with aircraft-

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[345] Jasjit Singh, "A Nuclear Strategy for India," in Singh ed., *Nuclear India*, pp. 310-311.

[346] The concept of "recessed deterrence" shares similarities with Cohen and Frankel's definition of "nuclear opacity." In a regime of opacity, emerging nuclear powers compartmentalize the nuclear weapon program within the state. The also maintain strict internal secrecy. However, the difference between these two concepts lies in their motivational drivers. In opacity, the driver is a commitment to nonproliferation norms.

[347] According to Scientific Advisor to the Defense Minister APJ Abdul Kalam's testimony before the Kargil Review Committee, weaponization was completed during 1992-94. The records of this and other conversations pertaining to India's nuclear weapons program from the early 1980s until 1998 are contained in the annexure to the report, which has not been declassified. See, "Nuclear Backdrop," *The Kargil Review Committee Report*, p. 205. The author's interviews with several senior retired Indian Air Force officers at the highest levels suggest that India achieved an air deliverable capability sometime in 1995; also see Raj Chengappa, "Tell Your President, I Keep My Word," *Weapons of Peace*, pp. 382-383.

based delivery systems stretched out for nearly seven years, until 1994-1995.[348] Similarly,

warhead integration on the short-range Prithvi ballistic missiles did not reach fruition until

1996-1997.[349] In other words, for the greater part of the decade, the default non-weaponized

state of the Indian arsenal stemmed from technical and managerial bottlenecks and not from

any conscious or rational choice to abide by nonproliferation principles.

After weapons became available in the mid-1990s, Indian leaders consciously decided to

maintain them in a disassembled form out of concerns for safety and strategic stability.

However, they elected against developing the soft institutional and organizational routines to

manage those weapons operationally. Once again, the evidence shows that cognitive biases

stemming from secrecy and heuristic decision-making, not arms control norms or cultural

understandings of nuclear weapons as political weapons shaped this choice. Likewise,

assumptions of an extant recessed operational capability turned out to be a vast over-

estimation. The earliest Indian operational routines, by which is meant the civil-military

chain of command, standard operating procedures, practice drills and ground rehearsals to

coordinate action within and across various agencies tasked with responding to a nuclear

emergency, were devised during the Kargil War[350] in the summer of 1999,[351] a year after

India conducted nuclear tests and formally claimed nuclear power status.

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[348] Chengappa, "The House Is On Fire," *Weapons of Peace*, pp. 332-333.

[349] Chengappa, "Why Play Pahalwan?" *Weapons of Peace*, p. 406.

[350] The Kargil War between India and Pakistan was triggered by the latter's incursion and occupation of mountain ridgelines on the Indian side of the line of control (LoC) in Kashmir. The war lasted between May and July 1999 and ended with a Pakistani withdrawal from all positions on the Indian side of the LoC. See, Jasjit Singh ed., *Kargil 1999: Pakistan's Fourth War for Kashmir*, (New Delhi: South Asia Books, 1999); Peter R. Lavoy ed., *Asymmetric Warfare in South Asia: The Causes and Consequences of the Kargil Conflict*, (Cambridge: Cambridge University Press, 2009).

[351] Senior Indian defense official 'X', non-attributable interviews (1 & 2) with author, October & November 2009 (New Delhi, India).

With the help of new evidence based on interviews with senior Indian civilian and military officials involved in the weaponization program during 1988-1999, I highlight some of the challenges India faced in developing operational nuclear forces under the gaze of a hostile nonproliferation regime. I show that in covertly proliferating states, political leaders fear pressures for nuclear rollback from nonproliferation watchdogs in the international system. These pressures force the proliferation process underground, deep into the bowels of the state. To ensure secrecy, sensitive nuclear weapons-related information is usually tightly compartmentalized and hived off within small and informal social networks. Decision-makers only partially mobilize epistemic actors and approach programmatic decisions sequentially. Secrecy concerns also create disincentives against decomposing problems and parceling them out for resolution to multiple bureaucratic actors.

Institutional secrecy thus creates management roadblocks in the path of hardware development and operational planning. Secrecy also generates demands for highly centralized and monopolist decision-making, a condition that accentuates cognitive biases among policy planners and prevents operational optimization. Finally, secrecy short-circuits the state's normal institutional oversight and control mechanisms. This last condition creates huge information asymmetries between decision-makers and their agents and compounds the challenges of management. The low information turnover and absence of the 'wisdom of the crowds' scrutiny by multiple individuals and agencies leaves many problems unidentified and unaddressed. Under these circumstances, most learning that occurs in the political system follows external shocks and crises. However, the severe regime of internal opacity and the unstructured nature of decision-making militate against policy optimization.

Secrecy Induced 'Seat-Of-The-Pants' Nuclear Learning

By 1987-1988 there were multiple signs that Pakistan had acquired nuclear weapons or was on the verge of acquiring the capability to build them. There was some uncertainty within India's nuclear establishment and its external intelligence agency, the Research & Analysis Wing, about the precise state of Pakistani nuclear advances.[352] However, Indian leaders had few doubts about Pakistan's direction. Triangulating through Indian intelligence sources, US government leaks and open source publications, they concluded that Pakistan was rapidly proceeding down the nuclear weaponization road.[353] By late 1988 it also became evident that there were no takers for Prime Minister's Rajiv Gandhi's global nuclear disarmament plan. Internally, pressure mounted on the prime minister from the defense and nuclear scientific agency heads (DRDO and BARC) as well as his principal secretary to act and ultimately in March 1989 Rajiv Gandhi authorized a program to commence weaponization.[354]

However, the weaponization program had a narrow technical focus. Between 1989-1994, it exclusively concerned the production of a small number of miniaturized and ruggedized fission weapons capable of safe and reliable delivery by means of combat aircraft. The weaponization process involved taking the weapon beyond its basic "physics package." This involved a reduction in the size and weight of the weapon, the use of metallurgically stabilized nuclear material, non-degradable high-explosive lenses and anti-corrosive materials within the weapon to ensure easier storage, maintenance and longer shelf life. It also involved the development of reliable electronic sub-systems such as high-voltage capacitors,

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[352] "Nuclear Backdrop," *Kargil Review Committee Report,* pp. 187-189.
[353] Ibid, pp. 187-193.
[354] B.G. Deshmukh, "Economic and Defense Matters," *From Poona To The Prime Minister's Office,* pp. 170-171.

electronic safety and arming systems and barometric fuses to ensure accurate height burst for the weapon.[355]

For successful air carriage, in this case the Mirage 2000, weaponization involved a reduction in the size, weight and casing of the weapon to avoid upsetting the aerodynamics and center of gravity of the aircraft.[356] It entailed redesign of the Mirage's wiring system to enable the bomb's electrical connectivity. Other tasks concerned the reconfiguring of the aircraft's electronic interface to enable the sighting, arming and safe release of the weapon; the rewriting of the aircraft's electronic interface to feed the bomb's ballistics into computers; electromagnetic pulse (EMP) protection and the strengthening of the suspension points for the weapon on the aircraft along with the "airframe along certain high stress zones and joints."[357] The third component of the weaponization program was the training of pilots in the arming, fusing and delivery of nuclear munitions.

The focus on the technical aspects of weaponization did not mean that India's national security managers had no appreciation for the accompanying institutional and organizational routines to embed those weapons. In the late-1980s for example, Prime Minister Gandhi directed DRDO chief Arunachalam to undertake precautionary routines to reduce some of the worst vulnerabilities of the fledgling Indian nuclear weapon program to a surprise attack.[358] Subsequently, with the weaponization decision behind him, Gandhi also felt an

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[355] Arunachalam, interview with author; K. Santhanam, Chief Technology Advisor to Science Advisor to Defense Minister, interview with author, May 2009 (New Delhi, India).
[356] Senior air force official 'S', interviews (1 & 2) with author, December 2009 & January 2010 (New Delhi, India).
[357] Air Marshal (retd.) 'N', non-attributable interview with author.
[358] Chengappa, "The Reluctant Believer," *Weapons of Peace*, p. 304.

imperative need to expand the circle of officials with knowledge of the program.[359] V.P.

Singh, who succeeded Gandhi, shared this concern and complained to his principal secretary

about the lack of shared institutional knowledge and planning.[360] Nonetheless, neither prime

minister undertook serious institutional measures to resolve their concerns.

Hence the weaponizaton program remained isolated from the institutional and

organizational demands of operational use. Even as knowledge of the weaponization

program expanded vertically within the scientific and engineering enclave tasked with its

various sub-projects, horizontal networks within the state privy to knowledge of the

program shrank. To oversee the effort, Gandhi appointed defense secretary Naresh Chandra

as coordinator.[361] However, because the program was treated as technical, relatively static

and sequential, there was no corresponding attempt to expand the planning and decision-

making circle to include cabinet members, a larger group of civil servants in the foreign

ministry or the military. B.G. Deshmukh, who served as both cabinet and principal secretary

to prime ministers Gandhi and Singh subsequently disclosed that although he closely

participated in the weaponization decision in 1988-89, his involvement in monitoring the

program's progress thereafter declined.[362] The prime ministers henceforth dealt directly with

Chandra and the heads of DRDO and BARC. Arunachalam himself complained in an

interview with the author about the "loneliness" and the "burden" of being one of the sole

[359] Chengappa, "The House Is On Fire," *Weapons of Peace,* p. 335.
[360] Chengappa, "End The Wink And Nudge Approach," *Weapons of Peace*, p. 355.
[361] Chengappa, "The House Is On Fire," *Weapons of Peace*, pp. 332-333.
[362] Deshmukh, "Economic And Defense Matters," *From Poona to the Prime Minister's Office*, p. 171.

institutional repositories of India's nuclear secrets in this period; without the luxury of being able to share them with anyone.[363]

Central to this lack of institutionalization and the horizontal expansion in the decision-making circle were concerns about potential breaches in secrecy. As Naresh Chandra, put it to the author, "…because of the fundamental inefficiency and sloppy approach of the bureaucracy…the latter could not be relied upon to keep matters secret. Hence the smaller the numbers [in the know] the better."[364] Chandra recalled an episode in the mid-1980s when foreign spies penetrated the office of P.C. Alexander, who served as principal secretary to prime ministers Indira and Rajiv Gandhi.[365] Secrecy, Chandra insisted, also enabled deniability to domestic constitutional authorities such as parliament and the office of the Comptroller and Auditor General.[366] However, the cause of Indian decision-makers acute desire for secrecy did not lie in domestic factors. It stemmed from their perceptions of India's economic vulnerability to US nonproliferation pressures. Three contingent factors in the early 1990s compounded their sense of vulnerability: the collapse of the Soviet Union which had been India's long-standing superpower ally, an acute balance of payments crisis and the resort to an IMF bailout package.[367] As a result, decision-makers shielded the weaponization program behind ever-higher walls of secrecy.

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[363] Arunchalam, interview with author.
[364] Ambassador (retd.) Naresh Chandra, interviews (1&2) with author, October and November 2009, (New Delhi, India).
[365] Ibid.
[366] Ibid.
[367] Ibid; Brajesh Mishra, National Security Advisor / Principal Secretary to Prime Minister (1998-2004), interview with author, October 2009 (New Delhi, India).

Ironically, in 1985-86, Prime Minister Rajiv Gandhi made a feeble attempt at institutionalizing national security planning and nuclear decision-making through a national security council. That attempt ended dismally within six months.[368] Next, he invited the service chiefs and the heads of the nuclear and defense research agencies to provide the government with preliminary numbers and cost estimates for a small nuclear force.[369] However, he allegedly "pigeonholed" that report.[370] During these years, service chiefs such as Generals Rao and Sundarji also took advantage of their excellent social ties with Prime Ministers Indira and Rajiv Gandhi to lobby them personally in favor of nuclear weapons.[371] For a short while, Rajiv Gandhi also was in charge of the defense portfolio in the cabinet. This gave then army chief General Sundarji, who was also by then the military's foremost expert on nuclear matters, unprecedented direct access to the prime minister.[372] Sundarji lobbied the prime minister in favor of the bomb with such alacrity that it aroused the ire of then Cabinet Secretary B.G. Deshmukh.[373]

However, once weaponization got underway, the program was cordoned off almost entirely. All information sharing was restricted to the heads of the AEC and DRDO, the incumbent prime minister and the president. Cabinet ministers, the group of department secretaries and the military chiefs were kept in the dark. According to Arunachalam, it was easy to exclude the army and navy chiefs because their services were not involved in the delivery program.[374] The "air force chiefs," special coordinator Chandra maintained, "only found out about it

[368] Chengappa, "The Reluctant Believer," *Weapons of Peace*, pp. 294-295.
[369] Ibid., 299-302; Perkovich, "Nuclear Capabilities Grow," *India's Nuclear Bomb*, pp. 273-276.
[370] Ibid., p. 275.
[371] Chengappa, "Do You Want Our Skulls Cracked?" *Weapons of Peace*, pp. 253-255.
[372] Deshmukh, "Economic And Defense Matters, *From Poona to the Prime Minister's Office*, pp. 164-167.
[373] Ibid.
[374] Arunachalam, interview with author.

[the weaponization program] because the air force was tasked with nuclear delivery."[375] To avoid unnecessary attention from foreign intelligence agencies, government officials and offices, which were normally the sites for specific programmatic decisions were also excluded. In contrast, the small group of officials with critical knowledge of the program remained involved in it regardless of career moves within government. Furthermore, these officials retained their involvement without the knowledge of their political or bureaucratic overlords.[376] This small and informal network of individuals did not emerge by design. As Chandra put it, "it emerged from necessity...almost to the extent that it became self-constituted…a minimal response by relevant individuals within the state who responded to a critical national security challenge."[377]

This fractional mobilization of India's nuclear epistemic communities effectively decoupled scientific-technical developments from the military's operational planning. The net effect of such excessive compartmentalization was that when the Kashmir Crisis suddenly erupted in 1990 with the very real possibility of nuclear use, the air force was in the dark about the parameters of the weapon then under development.[378] Because India had no suitable nuclear delivery system at the time there is some evidence to suggest that the air force autonomously and internally debated kamikaze missions as a possible nuclear delivery method in the late 1980s and early 1990s.[379] During the decade of the 1990s, its interaction with DRDO was primarily technical - restricted to modification of the Mirage 2000 for nuclear missions and the training of a handful of pilots to deliver nuclear weapons using dummy bombs. Until

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[375] Chandra, interviews (1&2) with author.
[376] Subrahmanyam, interview (2) with author.
[377] Chandra, interview with author.
[378] Ibid.
[379] Senior air force official 'S', non-attributable interview (2) with author.

1996 when Prime Minister Narasimha Rao privately confided to Air Chief Marshal Sareen that India possessed nuclear weapons, no air chief had official knowledge of the program.[380] The air force's role, in the memorable words of another air chief who served in the 1990s, was simply that of a "delivery boy."[381]

Thus in the pre-1998 era, the institutional link between the scientific agencies that designed and built nuclear weapons and the services was severely restricted.[382] The data on nuclear weapons effects, meteorology and demographics, the army used for preliminary estimates example, were derived from open-source literature such as foreign military training manuals or from military training courses that individual service members attended abroad.[383] A select few air force test pilots were trained in the mechanics of air delivery.[384] However, procedural plans for operational deployment and use were not developed with the user service. Nor did the government task the services with developing an epistemic community in the realm of nuclear strategic thought and warfare. To the contrary, senior cabinet ministers such as Narasimha Rao rejected suggestions from the defense ministry's Institute of Defense Studies and Analysis to educate the military on nuclear issues due to concerns that it would suggest to the outside world that "we are developing nuclear weapons."[385] India's schools where staff

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[380] Air Chief Marshal (retd.) S. K. Sareen, Chief of Air Staff, (1995-1998), interview with author, January 2010, (Gurgaon, India).
[381] Air Chief Marshal (retd.) 'O', Chief of Air Staff, non-attributable interview with author, December 2009, (New Delhi, India).
[382] Iyengar, Chairman, interview with author.
[383] Senior army officer 'Q', NBC Warfare Directorate: Army Headquarters, non-attributable interview with author, May 2009, (New Delhi, India).
[384] Subrahmanyam, interviews (1&2) with author.
[385] Subrahmanyam, interview (1) with author.

officers trained for higher command duties therefore offered no training or courses on nuclear subjects.[386]

Beginning in the early 1990s, a small number of civilian officials working with the scientific agencies drew up "paper plans" for an assured retaliation posture. But they did not give teeth to this posture by developing operational plans with Air Headquarters to move those weapons from the 'stockpile-to-target'.[387] A secret committee, the Arun Singh Committee, sat in the summer of 1990, *in the aftermath of the Kashmir crisis with Pakistan*, the subcontinent's first serious nuclear crisis, to plan India's nuclear emergency response measures.[388] The committee's "only specific recommendation," recalled the late K. Subrahmanyam who participated in its deliberations, was to "… to create separate storage for missiles and warheads…what should be the drill for them being brought together…and then…the communications from command and control."[389]

As George Perkovich reports in his history of the Indian nuclear weapons program, "…the group called for designating air force units to receive nuclear devices and deliver them according to previously prepared orders that base commanders would possess under seal."[390] The piecemeal nature of decision-making can be inferred from the fact that the committee's key recommendation was not implemented until certification of the air delivery platform in 1994-95. Only subsequently in 1995 did Prime Minister Rao approve the enactment of dispersal and concealment routines planned for safeguarding fissile cores and non-fissile

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[386] Admiral (retd.) Arun Prakash, "9 Minutes to Midnight," *Force* (July 2012), p. 4.
[387] Senior Indian defense official 'X', non-attributable interviews (1 & 2) with author.
[388] Perkovich, "The Nuclear Threat Grows," *India's Nuclear Bomb*, pp. 313-314.
[389] Subrahmanyam, interview (2) with author.
[390] Perkovich, "The Nuclear Threat Grows," *India's Nuclear Bomb*, p. 313.

trigger assemblies from a pre-emptive attack.[391] Meanwhile, wartime operations planning to

coordinate action between the air force and scientific agencies and to enable the air force

plan nuclear missions was delayed still further.[392]

Partial mobilization apart, the epistemic community's weak state of institutionalization

further minimized its capacity for policy learning, especially in so far it concerned integration

and coordination issues. Without doubt, many of the scientists and technologists in the

DAE and DRDO had long careers that spanned successive governments; sometimes as long

as three decades. Nuclear scientists such as Ramanna, Iyengar, Chidambaram, Kakodkar,

Sikka and their DRDO counterparts such as Nagchaudhuri, Arunachalam, Santhanam and

Kalam enjoyed long stints in government. Dr. Ramanna, the leader of the 1974 explosion

team for example, went on to become the chief scientific advisor to the defense minister, the

head of AEC, member of parliament and minister of state for defense. Arunachalam

continued for a decade as the scientific advisor to the defense minister and the lead advisor

on the weaponization program to five prime ministers. K. Santhanam who became involved

in the weaponization program in the mid-1980s, served as the coordinator between DRDO

and the Bhabha Atomic Research Center (BARC) in his position as chief technology advisor

to the defense minister's scientific advisor at the time of the 1998 tests.[393]

Their individually powerful positions notwithstanding, as a group the scientists were not

institutionalized within any agency such as a national security council or a secretariat that

could provide them a structured platform to advance their views. As members of an

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[391] Chengappa, "Tell Your President I Keep My Word," *Weapons of Peace,* p. 391.

[392] Senior Indian defense official 'X', non-attributable interviews (1 & 2) with author.

[393] For career trajectories of these officials see, Chengappa, *Weapons of Peace.*

epistemic community, the scientists and technologists existed as an informal social network. There were no established legal or even quasi-legal administrative rules of business to guide their interaction. Neither did they have independent access to other government agencies such as the military or power centers such as the cabinet or parliament. In the absence of legal and administrative authority, entrée and continued participation in the network depended on either a personal relationship with prime ministerial incumbents or with their coordinating agents.

These institutional weaknesses left the scientific-technological epistemic community in a weak position to extract "credible commitments" from political principals. From 1974 until 1998, the nuclear scientists were mostly unable to get successive prime ministers to authorize any further testing. Even after Rajiv Gandhi approved weaponization in the spring of 1989, the program was reduced to "bar charts" detailing "when the (bomb) trigger would be ready, what type of platform would carry the bomb, how the bomb was to be mated to a delivery vehicle, the type of electronic checks…" with the prime minister retaining veto over the passage of every technical threshold.[394] The armed services were never part of the network except at its very fringes.

A retired air chief who served in this period brutally summed up the institutional constraints of his office when he stated "…no air chief wants to approach the prime minister about nuclear issues only to be told to go mind his own business!"[395] Indeed as the air force's nuclear air delivery system came online by the end of 1995, some bureaucrats within DRDO

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[394] Deshmukh, "Economic and Defense Affairs," *From Poona to the Prime Minister's Office,* p. 171; Chengappa, "The House Is On Fire," *Weapons of Peace,* p. 335.
[395] Air Chief Marshal (retd.) 'O', non-attributable interview with author,

such as Santhanam supported operational planning with the air force. However, this was not the consensus view among the senior scientists and civilian bureaucrats responsible for policy planning. Senior air force officials who interfaced with them concluded that the scientists were only cogs in the wheel. They lacked the political clout to force operational planning on the political leadership.[396]As India's longtime weaponization manager Arunachalam put it, "Our task was to see, can we have an efficient and successful system? That is what I was involved in…I was not involved in saying…what would be…how many squadrons will be involved in this…what will be the pattern of the squadrons…and who will…and that particular part of it…we were not involved in those kind of discussions…force synthesis…the integration of technical, organizational, and ideational elements is a political decision, which must be coordinated from the top. Scientific bureaucracies working on the technical parts of a weapon system cannot on their own undertake such decisions." [397]

Compartmentalization, Cognitive Biases and Constrained Optimizing
The organizational dysfunction associated with the regime of internal opacity had the cumulative effect of stymieing India's operational nuclear capabilities during the entire decade of the 1990s. The compartmentalization of information meant that policy planners and their decision-making counterparts approached problems sequentially. Secrecy concerns similarly prevented problem decomposition and parallel planning by multiple agencies within government. Many technical bottlenecks therefore remained unidentified by planners until pressed by the force of circumstances. Secrecy concerns similarly led to weak intra-and inter-

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[396] Senior air force officer 'Z', non-attributable interview (2) with author, February 2010 (New Delhi, India).
[397] Arunachalam, interview with author.

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agency coordination and planning, especially in so far as command and control and operational planning went. Above all, institutional secrecy and the absence of multiple actors and agencies review contributed to policy based on false analogies and biases.

When thinking of nuclear operationalization, it is generally useful to draw distinctions between a "device" and a "weapon." A device, as Chuck Hansen defines it, can commonly be understood as "…fission and fusion materials, together with their arming, fusing, firing, chemical high explosive, and effects-measuring components, that have not yet reached the development status of an operational weapon…system designed to produce a nuclear explosion for purposes of testing the design, for verifying nuclear theory, or for gathering information on system performance."[398] But a weapon system is considerably different. It involves "the conversion or modification of a nuclear test device into a combat-ready warhead," which "includes the design and production of a ballistic casing (and any required retardation and impact-absorption or shock-mitigation devices) as well as special fuses, power sources, and arming and safing systems or equipment."[399]

If we use the above definitions as the base for measurement then India did not possess a nuclear weapon until at least 1990. To be sure Indian nuclear scientists were working on advanced boosted-fission and perhaps even thermonuclear weapon designs by the late 1980s. As early as 1982-83, they may have planned to test a lighter and more sophisticated version of the 1974 device. But the sequential nature of planning ensured that it wasn't until 1985-86 that Rajiv Gandhi's government put in motion a plan to develop a weapon system

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[398] Chuck Hansen, *U.S. Nuclear Weapons: The Secret History* (New York: Orion Books, 1988), p. 13.
[399] Ibid., p. 17.

of reduced weight and size that was safe, reliable and deliverable. India did not possess such a weapon system in 1986-87 when the Brasstacks crisis erupted with Pakistan. Nor did it possess such a weapon at the time of the Kashmir Crisis in 1989-90. Indeed, the doyen of Indian strategists and nuclear consultant to nearly all prime ministers since the late 1970s, K. Subrahmanyam subsequently disclosed that "in the period between 1987-1990 India was totally vulnerable to a Pakistani nuclear threat."[400]

Further, until the prime minster reached a decision in the late 1980s to commence weaponization, the scientific agencies did not seriously engage the air force to resolve the technics of nuclear delivery. Many observers in the 1990s assumed that India's Jaguar and Mirage combat aircraft were capable of performing nuclear missions from the late 1980s. However, the grounds for such claims are suppositions not facts. In India's case, Prime Minister V.P. Singh recalls DRDO chief Arunachalam briefing him in 1989 that "India could then only assemble nuclear weapons but not deliver them."[401] As he put it, "we could laboratory test everything…but the bomb delivery was still in progress."[402] More evidence of the lack of a delivery capability comes from then Chief of Air Staff S. Mehra who used the occasion of the 1989-90 Kashmir Crisis and the prime minister's concerns about a potential Pakistani nuclear strike to lobby for the removal of internal firewalls between the civilian development and military user agencies.[403] The prototype Indian nuclear device under

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[400] Subrahmanyam, "Indian Nuclear Policy," p. 44.
[401] Chengappa, "End the Wink and Nudge Approach," *Weapons of Peace,* p. 354.
[402] Ibid.
[403]Perkovich, "The Nuclear Threat Grows," *India's Nuclear Bomb*, p. 305; Shekhar Gupta, "Know What They Did That Summer," *Indian Express,* (August 12, 2006), http://www.indianexpress.com/news/know-what-they-did-that-summer/10366/, (May 2010).

development had until then not been shown to the air force.[404] However, because no positive response was forthcoming, he and the two other service chiefs concluded that India did not possess a ready arsenal at the time.

The modification of aircraft for nuclear delivery reliably and safely turned out to be a huge technical and managerial challenge that consumed the DRDO's attention for six years and perhaps more. It is a telling reminder of the hurdles proliferating countries face when transforming crude capabilities into operable systems. But it is an even more pointed reminder of the pitfalls of weak inter-agency planning and coordination. There was a major problem interfacing the nuclear weapon with the Mirage. Senior Indian air force officials recall that DRDO's original intent may have been to arm ballistic missiles with nuclear warheads and circumvent the air force entirely. However, the warhead developed was too large and heavy for ballistic missile carriage at the time.[405]

Resolution of these technical bottlenecks took between 1989-1994 to resolve. However, the problem as senior Indian air force officials at the highest levels viewed it was not one of technical challenges alone but of the compartmentalized system of information flows, planning and management. The government did not issue specific nuclear tasking for the

[404] Ibid.

[405] India began developing the short-range Prithvi ballistic missile as part of the Integrated Guided Missile Program in 1983. The maiden launch of the missile occurred in 1987. Flight trials or the Prithvi continued until the late 1990s. There is evidence to suggest that Indian defense agencies were able to modify warheads for ballistic missile delivery by 1996-1997. However, it is uncertain if the systems met operational standards of reliability. According to a former C-in-C, Strategic Forces Command, who spoke to the author on the condition of anonymity, even as late as 2003-2004, combat aircraft were the most flexible and reliable nuclear delivery systems India possessed. See Chengappa, "The Eyes of Yama," *Weapons of Peace,* p. 418; C-in-C, Strategic Forces Command, 'P', non-attributable interview (1) with author, April 2009, (New Delhi, India).

Mirages when they were acquired from France in the mid-1980s. Likewise, the air force was neither given nor asked for inputs on the size, weight, and dimensions of the proposed nuclear weapon. A senior individual with insider knowledge of the program volunteered to the author that one should assume that "India could have acquired an air delivery capability by 1996." Prior to that date the deterrent was a "paper tiger." To be sure nuclear weapons existed. However, he emphasized, "…capability is a function not just of the weapon but what you can actually do with that weapon." If a nuclear emergency had arisen in 1994-1995, the air force "may have been forced to do something." However, "given the large number of unresolved issues…the so many imponderables," it was difficult to estimate the likelihood of success.[406]

Further, optimizing decision-makers, after electing to weaponize India's nuclear capability in the spring of 1989, would have ordered policy planners to simultaneously think through command, control procedures and operational planning. However, due to the compartmentalized and sequential nature of planning, political leaders did not think it necessary to think through these institutions and procedures. During the Kashmir Crisis with Pakistan in 1989-90, for example, the Indian government found itself without a nuclear command and control system. Worse, it found itself without guidelines and procedures to respond to a nuclear emergency.[407] At the time, command and control just consisted of the prime minister, his principal secretary and the scientific advisor to the defense minister.[408] The ruffled prime minister conveyed his concerns to his principal secretary saying, "…this is scary. This matter cannot just be between the prime minister and the scientific advisor.

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[406] Ibid.
[407] Chengappa, "End the Wink and Nudge Approach," *Weapons of Peace,* pp. 353-356.
[408] Ibid., pp. 354-355.

Supposing someone attacks Delhi, there is no formal procedure as to who then decides what to do. We have to institutionalize it."[409]

Arun Singh the former Minister of State of Defense who the prime minister appointed in the wake of the crisis to review India's nuclear preparedness and make recommendations for a command control system found himself aghast at the bureaucratic chaos inside government. He thought "it…crazy that BARC[410] didn't know where DRDO stood or vice versa. Nothing had been worked out as to who was to control the weapons and under what circumstances and time frame we would strike back."[411] The Arun Singh Committee subsequently prepared emergency response procedures and command and control mechanisms. But it did not delve into operational planning.[412] Further, neither the armed services in general nor more specifically the air force found representation on the committee. Retired army chief General Sundarji served on the committee as a token representative of the services.[413] However, the sitting service chiefs knew neither of the committee's existence nor the specific nature of the general's inputs.

Indian decision-makers' obsessive desire for secrecy therefore resulted in a skeletal and tenuously institutionalized command and control system and the near total absence of operational planning between the scientific and military agencies. What this meant was that although India possessed nuclear weapons, its institutional and organizational capacity to press them into military operations was far from assured. A senior official who served at the

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[409] Ibid.
[410] BARC or Bhabha Atomic Research Centre is India's premier nuclear weapons research, design and development agency.
[411] Chengappa, "End the Wink and Nudge Approach," *Weapons of Peace,* p. 356.
[412] Subrahmanyam, interview (2) with author.
[413] Ibid.

highest levels of the Indian government at the time claims that it would be reasonable to assume that the government had prepared emergency action and coordination protocols by the mid-1990s. If a nuclear explosion occurred it would be the Department of Atomic Energy's (DAE) task to make an assessment. The DAE, which held custody of the fissile cores would then pass them on to DRDO, which would in turn assemble nuclear weapons and turn them over to the air force. The planners believed 72 hours would be a reasonable time to constitute a nuclear force and launch retaliation.

In the event of the prime minister's incapacitation, power would devolve upon the Cabinet Committee on Security (CCS).[414] But the likelihood of that event happening was thought low. A Pakistani nuclear attack, the officials believed, would be limited and symbolic and leave the functioning of the federal government relatively undisturbed. However, in the worst-case 'bolt-out-of-the blue' scenario that Delhi did indeed go up in a mushroom cloud, power would devolve upon a hierarchy of state governors and principals in the state civil service who would assume responsibilities of the federal government. And the military would function under a reconstituted civilian authority. India, the leaders of the nuclear network believed, was a "…big country. It would survive!"[415] But how, they could not tell.

The trouble with the above protocols was that they remained a secret even within the loose network of scientists who constituted India's principal policy planners during that time. Above all, they remained "paper exercises."[416] There were no written documents or standard operating procedures, a Red Book, for individuals to follow. Barring one or two officials at

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[414] The Cabinet Committee on Security (CCS) comprises of the ministers of external affairs, defense, home, and finance.
[415] Senior Indian defense official 'X', non-attributable interview (2) with author.
[416] Ibid.

the very top who knew of them in their entirety, other members of the nuclear network, never more than a dozen senior officials in any case, knew only fragments of them. Because little was committed to paper the institutional memory of the state beyond this network of officials remained a blank state.[417] Furthermore, the DAE and DRDO did not practice any emergency drills on the ground to test their coordination and emergency response.[418] From the mid-1990s onwards, air chiefs inferred that such protocols likely existed.[419] But they were told nothing of their content.

The president as the constitutional head of state was privy to some of this nuclear knowledge.[420] Similarly, a spare oral brief was made to new holders of the prime minister's office. However, if they were deemed disinterested, and at least three incumbents in the 1990s were,[421] their principal secretaries were briefed instead.[422] Beyond the prime minister and his secretary, no information was shared with ministers on the CCS or with federal governors and provincial civil service chiefs who might be called to assume responsibilities of government. The military leadership was equally clueless about how it was to function under a new civilian dispensation. As the senior government official with the God's eye view of the program at the time put it to the author: "command and control essentially meant gathering all the members of the group (nuclear network) under one roof as quickly as possible."[423]

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[417] Ibid.
[418] Senior Indian Air Force officer 'Z', non-attributable interview (2) with author.
[419] Ibid.
[420] Senior Indian defense official 'X', non-attributable interview (2) with author.
[421] The three prime ministers were Chandrashekhar, Gujral and Gowda. Arunachalam, interview with author; senior defense official 'X', non-attributable interview (2) with author.
[422] Perkovich, "India Verges On Tests," *India's Nuclear Bomb*, p. 377.
[423] Senior defense official 'X', non-attributable interview (2) with author.

The accounts of senior Indian policy planners from this period also reveal how secrecy, compartmentalization and monopolist decision-making freight policy with faulty analogies and cognitive biases. According to India's coordinator for nuclear planning, Ambassador Naresh Chandra, decision-makers' fear of compromised secrecy was the greatest factor that prevented them from institutionalizing the nuclear program and developing operational plans and procedures. They believed the "government was porous" and given the "fundamental inefficiency and sloppy approach of the bureaucracy…the latter could not be relied upon to keep matters secret."[424]

In their minds, the consequence of that discovery would be a US-led sanctions regime, analogous to the one Washington imposed on India's civil nuclear power sector in the wake of the 1974 nuclear test. But this second time around the "sanctions regime would be harsher" and "India's relative capacity in the 1990s to withstand sanctions…much lower."[425] Hence the "emphasis was on developing weapons" As Chandra put it, "…operations would follow at some later point."[426] The former Indian Deputy National Security Advisor Satish Chandra justified Indian decision-makers' actions similarly: "Remember, India was already under sanctions…technology denial regimes…and threat of further sanctions was always there. If the military were involved in a more substantial way, the game would be up…external powers would pick up the scent of India's nuclear weaponization at once…and sanctions would have followed."[427]

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[424]Chandra, interview (2) with author.
[425] Ibid.
[426] Ibid.
[427] Satish Chandra, Deputy National Security Advisor (1999-2005), interview with author, May 2009, (New Delhi, India).

The evidence therefore suggests that decision-makers' fear about the repercussions of their actions and not optimization was the key determinant that shaped the scope of India's operational posture in the 1990s. The statements above are also revelatory of the cognitive biases that pervaded their operating assumptions. Consider the belief of Indian decision-makers that weaponization could be held a secret if most information concerning it was left disaggregated within the state. This belief belies common sense as the direction in which India's weaponization program was headed, if not its scale and scope, was an open secret. From the early 1990s on, India and Pakistan were presumed *de facto* nuclear weapon powers. Scholars[428] and US government officials[429] believed both countries capable of assembling and exploding nuclear weapons. A 1993 US National Security Council report to Congress for example clearly states, "we believe India maintains a nuclear weapons development effort along with its active program to develop delivery systems for those weapons."[430] A 1996 US Department of Defense report was similarly blunt in its assessment: "India is believed to have a stockpile of fissile material sufficient for fabricating several nuclear weapons and could probably assemble at least some of these weapons within a short time of deciding to do so."[431]

Following on the heels of such assessments, the idea that a regime of "tacit" nuclear deterrence had come into existence in South Asia after the 1990 Kashmir Crisis became the

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[428] Perkovich, "A Nuclear Third Way in South Asia," pp. 85-104.

[429] For examples see speech by John M. Deutch, Director CIA, "Proliferation is Key Security Challenge for US and Allies, December 14, 1995; retrieved from *Federation of American Scientists,* http://www.fas.org/irp/threat/951027_dci.htm, (May 2012).

[430] National Security Council (1993), *Report to Congress on Status of China, India and Pakistan Nuclear and Ballistic Missile Programs*, (F94-1392), (Washington, DC); retrieved from http://www.fas.org/irp/threat/930728-wmd.htm (May 2012).

[431] Office of the Secretary of Defense (April 1996), *Proliferation Threat and Response*, (Washington, DC); retrieved from http://www.fas.org/irp/threat/prolif96/ (May 2012).

received wisdom.[432] Many US government entities and private think tanks in the early 1990

turned their entrepreneurial attention to promoting arms control and nuclear best practices

drawn from US-Soviet Cold War experiences to prevent a potential nuclear war in South

Asia, the region described as the "most dangerous place on earth." In light of all the

attention Indian and Pakistani proliferation received at the time, the belief among Indian

decision-makers' that the phenomenon could still be denied bespeaks of cognitive

dissonance, the psychological condition in which individuals mitigate the dissonant aspects

of their belief systems by altering them or adding new elements to make them more

harmonious.

Their further belief that foreign discovery of the weaponization program would trigger

consequences far worse than those that emerged in the wake of the 1974 nuclear test is also

an example of erroneous analogizing. It follows the bias train of the "availability" heuristic, a

condition in which decision-makers make judgments of the probability of an event occurring

and imagining its consequences not on the basis of any systematic thought process but on

the vividness of a prior event or events lodged in their memory.[433] In India's case, that event

was the 1974 nuclear test. Its consequence was US-orchestrated international sanctions

against India's nuclear power sector.[434] As a consequence of those sanctions, India's nuclear

power sector stalled. Electricity generation from nuclear power never exceeded 3 percent of

India's total power generation right until the last decade.[435] It was this memory and the

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[432] Devin Hagerty, "Nuclear Deterrence in South Asia: The 1990 Indo-Pakistani Crisis," *International Security,* Vol. 20, No. 3, (Winter 1995/1996), pp. 79-114.
[433] Gilovich and Griffin, "Introduction – Heuristics and Biases: Then and Now," pp. 2-3.
[434] Perkovich, "The Nuclear Program Stalls," *India's Nuclear Bomb*, pp. 190-225.
[435] See M.V. Ramana, *The Indian Nuclear Industry: Status and Prospects*, Nuclear Energy Futures: Paper No. 9 (Waterloo: The Center for International Governance Innovation, 2009),

presumed viability of the threat of economic and technological sanctions, which deterred successive Indian prime ministers from conducting further nuclear tests until 1998. However, the analogy they drew between the 1974 test and weaponization and weaponization-related operational planning was biased on three counts.

First, the consensus in the US policy community by the early 1990s was that India was capable of building and deploying nuclear weapons even if it had not done so already; and that a recessed capability probably existed in the bowels of the state. Second, examples of triggering events under US sanction laws at the time particularly the Nuclear Nonproliferation Act, were nuclear testing, the violation of IAEA safeguards agreements and cooperation agreements with the US.[436] Doctrine, procedures and operational plans, all intangibles, did not qualify as triggering events.[437] No doubt, existing laws could be read more expansively to fit the situation. However, compared to stark events such as nuclear testing, the development of doctrines, procedures and operational plans are a relatively ambiguous phenomenon. These are relatively harder to detect and it is generally more difficult to make determinations concerning them. Third and perhaps more significantly, since 1974, Indian nuclear, space and missile entities were already the target of US nuclear and other high-tech technology denial regimes.[438] The further threatened denial of Eximbank financing and loans from international financial institutions was indicative of limited and not blanket economic sanctions.

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http://princeton.academia.edu/MVRamana/Papers/405419/Indian_Nuclear_Industry_Status_and_Prospects, (May 2012).

[436] Richard H. Speier, Brian G. Chow and S. Rae Starr, "The Sanctions Process," *Nonproliferation Sanctions,* (Santa Monica: Rand, 2001), pp. 12-13.

[437] Ibid.

[438] Perkovich, "The Nuclear Program Stalls. *India's Nuclear Bomb*," pp. 190-225.

When questioned by the author, former India's former Deputy National Security Advisor Chandra rationalized the analogizing between the 1974 test and weaponization-related operational plans and procedures on grounds that "…there are laws on the books and then there are informal sanctions. The US has considerable discretionary power regarding sanctions…such as denial of aid, multinational loans, funds and so forth. India had to keep that in mind, when deciding how to deal with its covert nuclear status."[439] However, it remains doubtful if these rationalizations were ever subject to optimizing "truth tests" within India's secretive and monopolistic decision-making institutions at the time. The Indian decision-makers' belief in the credibility of US sanctions threats is further evidence that their judgments were clouded by the "representative" heuristic to the extent those threats were deemed representative of Washington's general population of proliferation-related sanctioning acts. The venerable K. Subrahmanyam pointed out the logical fallacy of Indian economists and policy planners when he said, "…the perception was mostly based on what they heard from their American counterparts, and not comprehensive analysis of US behavior pattern when their interests clashed with their declaratory nuclear policies."[440]

Indeed, had Indian decision-makers investigated the universe of US proliferation-related sanctioning behavior they would have discovered a history of US opposition and then grudging acceptance of most proliferating countries. The list of states included Britain, France, China and Israel.[441] During the 1980s and 1990s Washington turned a blind eye to Pakistan's nuclear program and proved helpless in stanching Chinese-Pakistani nuclear and

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[439] Chandra, Deputy National Security Advisor (1999-2004), interview with author.

[440] K. Subrahmanyam, "India's Nuclear Quest," in K. Subrahmanyam with Arthur Monteiro, *Shedding Shibboleths,* p. 142.

[441] Subrahmanyam, "Nuclear Realities," *Shedding Shibboleths*, pp. 94-107; also see, Maria Zaitseva, *When Allies Go Nuclear: The Changing Nature of the American Response to 'Friendly' Nuclear Programs,* PhD Dissertation (Ithaca: Cornell University, 2011).

missile cooperation.[442] Indian decision-makers would have also discovered that US decision-makers used sanctions selectively, applied them narrowly to specific entities, often issued waivers and at other times declined to make determinations at all.[443] Above all they would have found that US policy makers constantly weighted the restraining effects of sanctions against the loss of leverage on a targeted state.[444] Indeed the limited US sanctioning of Pakistan under the Symington Amendment in the 1990s signaled the floor for punishment.

In this regard, one of the most dramatic instances of unstructured decision-making comes from India's former National Security Advisor (NSA) Brajesh Mishra. When asked by the author if the threat of sanctions weighed on his mind before the BJP government ordered tests in 1998, his response was: "I was never bothered…I didn't even consult anyone. My gut feeling was that once you tested and you were clear about your economic reforms then you will begin to have dialogue with all the countries… I was quite clear that India being such a big country, if you only had the guts at the decision-making level, had that bent of mind…you could do it."[445] Most of the evidence therefore demonstrates that Indian decision-makers were not rational optimizers. If anything, they were cognitive misers.

The Impact of Limited Agent Competition and Weak Monitoring on Operations

Secrecy, compartmentalization and low information turnover also had the combined effect of creating a weak nuclear weapons-related knowledge market within the state. The regime of opacity not only made the program less transparent within and without, but it also reduced the ability of Indian decision-makers to monitor its performance. Leaders in

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[442] Subrahmanyam, "India's Nuclear Quest," *Shedding Shibboleths,* pp. 138-140.
[443] Speier, Chow and Starr, "The Sanctions Process," *Nonproliferation Sanctions,* pp. 16-23.
[444] Ibid., pp. 23-29; "History and Lessons Learned," *Nonproliferation Sanctions,* pp. 35-52.
[445] Mishra, interview with author.

organizations generally use three mechanisms to reduce the transfer cost of information pertaining to their subordinates and their performance. The first is visibility, which renders actions easily legible. The second is agent competition, a process that allows information to percolate up the management chain. And the third is the institution of bodies of epistemic actors to vet the quality of programs and their progress. All three conditions were absent from the weaponization project with deleterious consequences for both hardware development and operational aspects of policy.

Historically, India's nuclear, space and defense research and development agencies have enjoyed a high degree of autonomy. Due to the pursuit of "strategic autonomy" Indian leaders have institutionally exempted then from the normal oversight of the state's auditory authorities. The heads of agencies such as DRDO, BARC and ISRO typically interact with prime ministerial incumbents directly, circumventing existing constitutional and administrative channels of authority. The state extends generous budgetary support and fast tracks most projects pursued by these agencies. Although prime ministerial representatives such as the cabinet secretary and the principal secretary sit on the governing boards of these agencies, yet in the absence of independently instituted monitoring bodies and the vast information asymmetries that prevail in technical settings, political oversight is limited. This remarkable degree of autonomy in India's otherwise over-regulated state has earned this clutch of agencies the title of "strategic enclave."[446]

Most observers of the "strategic enclave" agree that this unique set of institutional circumstances is responsible for many management-related project failures in the past. The

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[446] Itty Abraham, "India's Strategic Enclave: Civilian Scientists & Military Technologies," Vol. 18, No. 2 (Winter 1992), pp. 231-252.

DRDO in particular has acquired a reputation for being high on promises and low on delivery. High costs, time overruns and shoddy workmanship characterizes many of its ambitious defense projects among others such as the main battle tank (MBT) and the light combat aircraft (LCA) among others.[447] Political and civilian bureaucratic oversight of the DRDO is weak. As a senior defense official put it to the author, "the civilian defense R&D bureaucracy prioritizes ideological goals when conceptualizing and planning projects – they favor indigenization and self sufficiency and this is what the politicians love to hear… a situation made worse because the politicians largely rely on inputs from their civilian advisors and lack independent means to appraise programs."[448]

Nonetheless, the armed services as the end users typically play the role of the external monitoring agents. The services critique projects at the conception stage, issue general services quality requirements (GSQR) requirements, depute representatives to the labs, conduct field trials and ultimately resist accepting weapon systems until kinks are resolved. Prominent among examples of such successful interventions is the case of the navy's technical audit in the 1980s, which persuaded two prime ministers to kill three reactor

[447] "Arjun Main Battle Tank," *Government of India Press Release,* May 5, 2008, http://pib.nic.in/newsite/erelease.aspx?relid=38445 (May 2013); Ajai Shukla, Armed Forces Prefer Russian Armor," *Business Standard,* April 19, 2008, http://web.archive.org/web/20110607132933/http://www.business-standard.com/india/storypage.php?autono=320574 (May 2013); Manu Pubby, "Arjun tank fails winter trials, Army Chief writes to Antony," *Indian Express,* April 17, 2008 http://www.indianexpress.com/news/arjun-tank-fails-winter-trials-army-chief-writes-to-antony/297768/ (May, 2013); Amitav Ranjan, Arjun, Main Battle Tanked," *Indian Express*, November 27, 2006, http://www.indianexpress.com/news/arjun-main-battle-tanked/16589/1 (May 2013); "Perform or Perish: Antony Tells DRDO," *Zee News.com*, May 29, 2013, http://zeenews.india.com/news/nation/perform-or-perish-antony-tells-drdo_851697.html (May 2013); "Don't Extend Tejas Deadline, Antony Tells DRDO," *Zee News.com*, March 24, 2013, http://zeenews.india.com/news/nation/don-t-extend-tejas-deadline-antony-tells-drdo_837460.html (May 2013);
[448] Senior Indian defense official 'F', non-attributable interview with author, December 2009, New Delhi, India.

designs prepared by BARC for the top-secret nuclear submarine project.[449] Thereafter, India

sought Russian assistance in the design and integration of the submarine's nuclear power

plant.[450] Similarly, the services' critique of the short-range air defense missile project, first

launched as part of the Integrated Guided Missile Defense Program (IGMDP) in the 1980s,

led to its subsequent cancellation[451] and procurement from Israel instead.[452] Technical audits

by the armed services have also forced DRDO to markedly improve its MBT and LCA

prototypes.

However, secrecy and compartmentalized planning on nuclear weaponization precluded

agent competition between DRDO and the air force. Between 1987-1990, as a senior air

force official disclosed to the author, the DRDO did not share details concerning the

"hardware" or "drawings" with the air force's testing establishment.[453] As a result, the

"boffins" who developed the weapon, recalls another senior air force officer who served at

the time, "developed it independently without reference to the delivery platform.[454] There

was a problem with carriage because the weapon was too long."[455] This was cause for

concern especially during the "rotation maneuver during take off stage. A skilled Mirage

pilot could have pulled it off…but not just any pilot," a senior air force officer with a

[449] "Victimized By the Official Secrets Act: The Story of Dr. B.K. Subbarao," *Manushi* Issue 108, http://www.indiatogether.org/manushi/issue108/subbprof.htm (May 2013).

[450] Rear Admiral (retd.) A.P. Revi, "Arihant: The Annihilator," *Indian Defense Review,* Vol. 24, No. 4, October-December 2009, http://www.indiandefencereview.com/spotlights/arihant-the-annihilator (May 2013).

[451] "India Shuts Down Trishul Missile Project," *Rediff on the Net*, February 27, 2008, http://www.rediff.com/news/2008/feb/27trishul.htm, (May 2013).

[452] "India and Israel's Barak SAM Development Project(s)," *Defense Industry Daily*, January 24, 2013, http://www.defenseindustrydaily.com/india-israel-introducing-mr-sam-03461/ (May 2013).

[453] Senior Indian air force officer 'M', non-attributable interview (1) with author, December 2009 New Delhi, India.

[454] Senior Indian air force officer 'Z', non-attributable interview (2) with author.

[455] Ibid.

ringside view of the program told the author.[456] The "…size of the weapon itself, its length and weight upset the aerodynamics and center of gravity of the aircraft."[457]

After 1990, recalled another air force official, "the only details shared concerned the size and dimensions of the weapon container and its weight in general…so that DRDO would be assured that the bomb could be slung beneath the aircraft and there would be sufficient ground clearance. But no additional information was shared with the air force at this stage."[458] However, there were other aspects that needed resolution such as the aircraft's electronic interface and sighting systems to enable the arming and release of the weapon.[459] The electronic interface could not be reconfigured without what one air force officer described as access to the "manufacturer's database" and computer source codes. The aircraft also required extensive rewiring for electrical connectivity to enable the bomb's functions.[460] The Mirages India had acquired from France in the mid-1980s were not nuclear-certified. There were thus concerns that a post-detonation electromagnetic pulse (EMP) could interfere with the aircraft's computer-controlled fly-by-wire, communications and other electronic systems. According to one senior air force official, "…in the early 1990s, the air force was thinking of one-way missions…it was unlikely that the pilot deployed on a nuclear attack mission would have made it back."[461]

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[456] Air Marshal (retd.) 'N', non-attributable interview (2) with author.
[457] Senior Indian air force officer 'S', non-attributable interview (2) with author.
[458] Senior Indian air force officer 'L', non-attributable interview with author, December 2009 New Delhi, India.
[459] Ibid.
[460] Senior Indian air force officer 'Z', non-attributable interview (2) with author.
[461] Senior Indian air force officer 'S', non-attributable interview (2) with author,

Prior to 1990, an air force officer explained, "DRDO thought they could do the project all by themselves...except that they needed an aircraft. But when DRDO couldn't manage or understand things, they came to the air force."[462] Eventually a team from the air force was roped into the project. Another air force officer from Air Headquarters disclosed that "the air force core team likely included a "flight test engineer and three or four assistants, an air frame man, an electrical and electronics man, and a mechanical engineer…besides the test pilot. The DRDO would have had its own team… there are some tasks that DRDO could not have done without the air force." [463] Nevertheless, despite partial cooperation between the two agencies, the air force's test establishment was excluded from the certification process. As a result, the air force did not know the methodology DRDO used to certify the integration of the weapon with the delivery platform.

A senior air force officer who debriefed the test pilot involved in the certification trials emphasized that the air force has a clear system for designing, developing and accepting weapon systems. It maintains a vast and varied test establishment with highly specialized and experienced personnel to integrate weapon systems with various platforms. However, in the case of the weaponization program, the air force could not adhere to its organizational rules. It was forced to "break rules" which from an end-user perspective is unacceptable. As he put it, "the need for secrecy is understandable as long nuclear weapons are treated as symbolic… but once requirements shift to operations, it is absurd to keep the user service on the sidelines." In his words,

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[462] Ibid.
[463] Air Marshal (retd.) 'K', non-attributable interview with author, July 2010, New Delhi, India.

"when I say I have a test establishment…it starts with a project engineer of a particular project, and this project engineer will work under a chief project officer who is a senior test engineer…so every project that this project engineer is doing, there is a project engineer on top…there is a parallel branch comprising of flight test engineers…each involved in the project... and everything they do is overseen by senior flight-test engineers…and there are test pilots doing projects working with these engineers. Senior test pilots and so forth oversee the test pilots themselves. So it is a team effort…and it is the experience of the entire system that is bearing down on the team. So you can certainly pick out individuals from these institutions…but you will not get the institutional backing…the institutional strength. I as a test pilot can do nothing unless I have access to the test establishment's computer databanks and engineers."[464]

Until 1994, DRDO conducted experimental modifications on just one Mirage 2000 with a single test pilot. There was no back up.[465] But even after that date the internal feedback Air Headquarters received from its "boys" was that the plane's modified systems had not achieved the degree of reliability considered *de rigueur* for performing sensitive nuclear missions.[466] The whole project, senior air force officers claim, would have been better executed if the service had been involved in the planning from the beginning to the end. A participant in the certification of the air platform observed that there was a "hand hammered quality" to the aircraft that were modified for nuclear missions. There were several failures. But with passage of time and some introspection, the system was further refined. However, there

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[464] Senior Indian air force officer 'M', non-attributable interview (2) with author, February 2010 (New Delhi, India).
[465] Senior Indian air force officer 'Z', non-attributable interview (2) with author.
[466] Ibid.

were "limitations" in the final product. It was "less capable, less reliable, and generated less confidence."[467]

This same individual with insider knowledge of the program volunteered to the author that "…the conceptualization of any weapon system must be based on ground reality requirements…you don't create weapons and platforms in isolation…[they] must be based on quality requirements of the user service. The political climate must also be very clear…can the weapon that is being developed be used? And if not…why was it developed? The scientists and weapons development agency might have a good idea…but to transform it into a usable weapon…the user must be in the loop…must have a total picture."[468] Politicians, he continued, "get carried away by stories of India's apparent progress…stories that make banner headlines...but they lack the expertise and time" to appraise technical details.[469] Hence the appraisal process devolves upon senior civil servants. In the case of weaponization however, even that process was "hijacked" by DRDO and BARC. The politicians relied on the civilian nuclear coordinator to keep a tab on the scientific agencies. However, in the absence of independent scientific review boards and auditing processes, civilians received no independent feedback. Only the "end-users can provide independent feedback…but their inputs were not sought."[470]

The lack of agent competition between the scientific agencies and the military also stymied the process of operational planning once weapons became available. Without doubt, the irrational fear of US sanctions was the major cause for the political paralysis on this front.

[467] Ibid.
[468] Ibid.
[469] Ibid.
[470] Ibid.

However, senior military leaders who spoke to the author were unanimous that neither the scientists nor the political decision-makers understood the complexities of operational planning. In the case of conventional war planning, for example, the military has acquired almost exclusive monopoly over operational plans due to the lack of civilian bureaucratic expertise. Civilians tend to set political goals and leave it to the services to work out the logistics of operations.[471] However, in the nuclear domain, the military's direct lack of access to political decision-makers and limited technical knowledge of the nuclear weaponization project created institutional bottlenecks where it was unable to disabuse them of the simplistic belief that the technical capacity to deliver weapons was tantamount to an operational capacity.

Former DRDO Chief V.S. Arunachalam summed up the scientific agencies' technical understanding of operational readiness to the author by arguing,

> "If you are saying that the air force didn't have the aircrafts ready…then you are wrong. This is not a situation where we say: we are going to use a nuclear weapon…get an aircraft ready…so that it can carry it…make it ready so that it can withstand the EMPs…nothing of the kind. It's ok…now I get ready…now it can take it on the wings or it can take it on the fuselage…nothing of the kind. I am sure that there was a reasonable amount of information that had been worked through…no pilot would have carried the weapon without knowing what he was carrying. No pilot would have gone there without knowing how to drop it…how to fuse it."[472]

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[471] Srinath Raghavan, "Soldiers, Statesmen and India's Security Policy," *India Review,* Vol. 11, Issue 2, (May, 2012), pp. 116-133.
[472] Arunachalam, interview with author.

For the air force planners however, weapon delivery and pilot training were only the tip of the fighting spear. To bring that fighting tip into action, the resolution of three other conditions was necessary. The first consisted of procedures to coordinate action among the scientific and user agencies. To this category belong timelines for the movement of aircraft, the identification of weapon storage sites, the training of ground crew in weapon storage, weapon movement and loading procedures. Other routines would concern safety and security checks on the aircraft and the weapon. As one senior air force planner explained to the author:

"The pilot learns how to handle the weapon, and its impact on the platform during flight…vibration characteristics etc. It's fine to give the air force dummy weapons to train with. We are now talking about pilots being trained to handle the weapon system in flight, the ground crew being fully trained to handle the weapon on the ground…the safety standards have to be very high. All instructions have to be written down precisely. Where do you arm the aircraft? You have to arm the aircraft in relative isolation…because if you have an accidental explosion, you don't just lose one aircraft, but you lose 20 aircraft…these are all practices that have evolved over the years…especially on how to handle weapon systems…"[473]

In the second category would come target identification and mission planning. Geography, meteorology, demography and cultural factors all go into target selection, a political decision. Among other things, the air force would have to identify air bases for potential deployments, and experiment with combinations of electronic jamming and escort aircraft for different mission targets. It would also have to plan decoy missions to divert attention and increase

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[473] Senior Indian air force officer 'M', non-attributable interview (2) with author.

the chances of penetrating a heavily defended airspace in a country on high alert in anticipation of a second strike. For example, an Indian Air Force study conducted in the early 2000s highlighted the logistical challenges of planning nuclear missions against Pakistan. It showed that a single mission alone could tie up as many as 60 aircraft to assist the penetrating nuclear vector.[474]

In the third category are pilot communication protocols to abort missions due to geostrategic changes, technical emergencies as well as procedures for weapon jettisoning and retrieval in the event of an accident or flight diversion. Included in this category would be protocols to fuse and arm the weapon in the time just before release over a target to minimize the risk of explosion over friendly territory or off-target.[475] Senior Indian air force officers point to three major challenges of nuclear mission planning that were left unaddressed prior to 1999. First, a nuclear mission would have involved a 'nap-of-the-earth' flight profile. During such missions attacking aircraft typically hug the ground to escape detection by enemy radar. But the Indian Mirages were not equipped with terrain clearance radars.[476] Hence targets and mission routes would need careful identification and mapping in advance. However, no target lists were provided to the air force.[477] Second, real-time communications are difficult when combat aircraft execute 'nap-of-the-earth' flight profiles because the earth's curvature renders the aircraft invisible to both enemy and friendly radar. Advanced air forces typically overcome the problem of command and control by

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[474] For example, a typical nuclear task force would include two nuclear-armed aircraft, three to four electronic counter measures escort aircraft, three to four aircraft for air defense and a similar number to suppress enemy ground defenses. A single mission would comprise 15-20 aircraft and at least two or three decoy missions would be planned simultaneously. See, Pravin Sawhney, "Bombed," *Force,* (February 2004), p. 8.

[475] Senior Indian defense official 'A', non-attributable interview (1) with author.

[476] Air Marshal (retd.) 'N', non-attributable interview (2) with author.

[477] Senior Indian defense official 'A', non-attributable interview (1) with author.

communicating with pilots via satellite or airborne surveillance and command posts perched at high altitudes. Since India lacked both at the time, it would have had to rely on relay aircraft to keep the political leadership in constant touch with the pilot during the length of a nuclear mission. However, the use of relay aircraft complicates logistics and mission planning.

More problematic however, the process would require written procedures to enable all parties share a common understanding of what those procedures are. If such procedures existed at all prior to 1999, the air force did not know of them.[478] Third, prior to 1999, the air force did not know who possessed the codes for arming nuclear weapons and how those codes were to be deployed during a mission. Indian weapons at this time did not incorporate permissive action links that would permit arming the weapons at will. The assumption in the air force was that the task of arming the weapon would fall on the pilot at a designated time during flight. However, the air force and the scientific agencies did not conduct practice drills to test the communication and weapon arming protocols during a potential nuclear mission.[479]

A number of senior air force officials, including those who served at the highest levels, are unanimous in their account that operational plans and procedures to execute nuclear missions are a post-1998 phenomenon. They concede that civilian officials and the scientific agencies had likely thought some of these issues through prior, but did not share them with the air force. For example, Arunachalam insisted to the author:

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[478] Air Marshal (retd.) Ajit Bhavnani, C-in-C, Strategic Forces Command, interview with author, February 2010, New Delhi, India.
[479] Ibid.

"…yes…yes…call it the 'Red' book or 'Blue' book…or something…they were clear…at no time a weapon was orphaned out…the weapon systems came with detailed instructions…when to use it, where to use it, how to use it…and all this would have been determined at the prime ministerial level…"[480]

However, a senior air force official who served during the 1990s recalls querying Naresh Chandra, the government's coordinator on nuclear planning since 1989, on some of the mission planning procedures. But Chandra, claims the official, "behaved like the typical bureaucrat…he sat like a frog…maintained silence…remaining in an information denial mode."[481] Nor was the air force given tasking orders to prepare internal procedures to program its own response to a nuclear emergency. Arunachalam's view was "…the numbers are so small…the system could be beautifully worked out…"[482] But a principal staff officer at Air Headquarters estimated the chances of mission success in the first half of the decade "at less than 50 percent."[483] Another senior air force officer from the 1990s who participated in the air delivery platform's certification trials and demitted office in the latter half of the 1990s, demurred from even speculating on the probability of mission success. According to him, nuclear missions were the "nightmare scenario" because so little was "…shown to the air force on the ground."[484]

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[480] Arunachalam, interview with author.
[481] Senior Indian defense official 'F', non-attributable interview with author.
[482] Arunachalam, interview with author.
[483] Air Marshal (retd.) 'N', non-attributable interview (2) with author.
[484] Senior Indian Air Force officer 'Z', non-attributable interview (1) with author.

Conclusion

What all this data tells us is that India's capacity to explode a nuclear weapon during the 1990s was not in doubt. However, its institutional capacity to explode nuclear weapons instrumentally over a target in pursuit of political goals remained very much so. Between 1989 and 1999, Indian decision-makers responded to structural pressures and ordered the building of nuclear weapons. But they did not seek to embed those weapons inside organizational and procedural frameworks that would give them operational significance. In the process they opened a vast operational gap, which left the Indian state vulnerable.

India's case provides us a window to observe some of the technical, institutional, organizational and procedural challenges of developing operational capabilities in secrecy. Its take away point is that a state may be generally good at adapting to environmental pressures. But it may be simultaneously weak at organizational learning. Adaptation means tactical adjustments to environmental pressures without an overarching alignment between means and ends. Learning implies strategic changes in the ways states apply themselves to problems and seek solutions. We should therefore not assume that revolutions in institutional and organizational thinking automatically follow in the wake of technological breakthroughs.

The take away point of this chapter is that rational decisions are empirically impossible in highly restricted and monopolistic decision-making environments. Problem decomposition, parallel processing and institutional oversight are the precursors for optimization. But this is precisely what decision-makers in the executive cone of proliferating states strive to avoid. Their primary reason for this avoidance behavior is to escape the hostile scrutiny of the nonproliferation regime. However, the price of secrecy is sub-optimality. As with firms in

the marketplace, decision-makers and states cannot learn in the absence of rapid information turnover, "truth tests," the 'wisdom of the crowds' logic of multiple agency scrutiny and structured thinking. Indeed, the Indian decision-makers' un-systemized nuclear decision-making, as this chapter process traces at considerable length, is a testimonial to these theoretical findings.

In the next chapter I show that the negative path dependent effects of such institutional legacies can linger even after states give up their cloak of secrecy. For example, even after India formally claimed nuclear power status in 1998, until at least 2003-2004 Indian decision-makers retained many of the institutions and practices of the past: weakly institutionalized epistemic networks, compartmentalized information, the absence of review processes and a disaggregated process of policy planning. For these reasons, until at least 2003-2004, there was a considerable lag in the operationalization of the Indian nuclear force. Some of India's defense reforms take aim at these institutional weaknesses. However, the successful resolution of intra- and inter-agency coordination problems remains the central challenge in the operational management of India's nuclear forces.

CHAPTER FIVE

THE INDIAN STATE'S POST-1998 NUCLEAR AGENCY: THE EFFECTS OF SLOW INSTITUTIONAL AND ORGANIZATIONAL REFORMS ON NUCLEAR LEARNING

Post-1998, Indian decision-makers have become more socialized into the operational logic and practices of nuclear deterrence. The reasons for this have to do with: (a) the strength of the epistemic community's institutionalization within the state; and (b) the openness of the state's decision-making structure. Both developments are related to decision-makers' formal commitments to taking Indian nuclear capabilities beyond technological symbolism and transforming them into realizable forces on the ground. The latter goal, the commitment to transform symbolic into operable forces, has forced political decision-makers' to expand the mobilization of India's nuclear epistemic community as well as to institutionalize a new epistemic community in the form of the military's Strategic Forces Command (SFC) to manage nuclear forces.

The end of the internal regime of nuclear opacity has also begun to transform the pre-1998 organizational pattern of nuclear decision-making within the state. The earlier pattern prized compartmentalization and disaggregation of information, organizational conditions that aggravated the scope for heuristics and cognitive biases in decision-making. The new structure rests on information sharing and institutionalized review processes. Also visible are the first hints of independent referee institutions capable of overseeing "truth tests" by rival claimants of knowledge. These latter processes have partially injected a semi-'wisdom of the

crowds' logic into the decision-making process producing outcomes that are more rational and optimal.

The process of formal socialization and institutionalization, however, only began to take shape from the middle of the last decade. Between 1998 and 2004, Indian decision-makers retained the legacy institutions and practices of the past: weakly institutionalized epistemic networks, compartmentalized information, the absence of review processes and a disaggregated process of policy planning. For these reasons, until at least 2003-2004, there was a considerable lag in the operationalization of the Indian nuclear force. Many informal decisions made in the first half of the decade stemmed from the absence of structured and deductive planning. These decisions, in so far as force lethality is concerned, have produced a negative path dependent lock down effect. No further optimization is possible on the latter end short of completely overturning the status quo.

Since mid-decade, the military's institutionalization within the nuclear policy planning process and more structured decision-making in the PMO, have partially streamlined intra- and inter-agency cooperation. Standard operating procedures and operational routines to manage the nuclear force have taken institutional root. However, many intra-agency and inter-agency institutional anomalies remain unresolved. The late institutionalization of the SFC has meant that it has to compete against legacy institutions such as the scientific agencies, which have historically controlled the nuclear weapons program. The military's feeble technical epistemic base, itself an institutional legacy of the past, limits the degree of independent oversight that it can exercise over its scientific counterparts. However, the military has partially succeeded through persistently lobbying civilian decision-makers and

institutional layering, to effect the beginnings of a shift from "negative" command and control institutions toward more "positive" procedure-based institutional practices. As in the pre-1998 era, the fundamental conflict between India's civilians and the military remains the logistical management of India's nuclear forces.

In this chapter I compare the process of an operationally centric nuclear epistemic community's institutionalization within the state between the first and latter halves of the last decade. I present evidence to show that weak institutions and monopolistic decision-making organizational processes in the first half of the decade produced sub-optimal outcomes, whose effects are now almost irreversible. However, changes in the state's institutional and organizational practices from the latter half of the decade have produced outcomes that bespeak of nuclear learning. Finally, I conclude by offering an assessment of the state of India's post-1998 operational nuclear posture.

Weak Institutionalization of Epistemic Actors and Delayed Learning

India's stepping out of the nuclear closet in 1998 was a game changer. The end of external nuclear ambiguity paved the way for the collapse of the regime of internal ambiguity as well. It helped relocate the nuclear weapons program from its narrow technical confines and embed it into a broader template of ideas, institutions and organizations, a process that has given meaning to the idea of force development. The "expanding" and "interconnected" nature of the goals in turn created demands for wider mobilization of the epistemic community: the strategic analysts, the civilian bureaucrats, and the military. More significantly, it forced political decision-makers to institutionalize the military's role in the policy planning process.

India's national security-related institutional developments in the post-1998 decade make comparisons to the Cambrian age apt when complex life forms exploded in frenzy across earth. Institutional reforms in India too exploded in the aftermath of the 1999 Kargil War and the Kargil Committee Report,[485] which channeled nearly four decades of the defense epistemic community's angst with national security institutional stasis within the state. The movement for institutional reforms, which had begun gaining strength from the late-1980s and early 1990s, received full expression in the 2000 Group of Ministers (GoM) report on national security reforms.[486] Reforms touched every aspect of decision-making: long-term national security planning, intelligence collection and aggregation, "jointness" among the three armed services, and the recasting of civil-military relations.[487] The operational management of the nuclear force too was part of the reform process.[488] However, political decision-makers accorded it low priority. It wasn't until 2003-04 that the military gained institutional authority in nuclear force planning and management alongside the scientific agencies.[489] Further, the nature of the military's institutionalization in force management, as the evidence presented below shows, was weak.

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[485] The Indian government appointed the Kargil Review Committee in the aftermath of Pakistan's aggression against India in Kargil in the summer of 1999. The committee's brief was: (a) to review events leading up to the events in Kargil; and (b) to recommend national security reforms to prevent such events from recurring. See, "Appointment, Approach and Methodology," *From Surprise to Reckoning: The Kargil Review Committee Report,* p. 25.

[486] Mukherjee, "Setting the Stage: The Precursor to Reforms," *Failing to Deliver*, pp. 9-22.

[487] Chandra, Deputy National Security Advisor (1999-2004), "Slow, But Steady: Evolution of the National Security System," pp. 49-51.

[488] Admiral (retd.) Arun Prakash, "India's Higher Defence Organization: Implications for National Security and Jointness," *Journal of Defence Studies,* Vol. 1, No. 1, (August 2007), http://www.idsa.in/jds/1_1_2007_IndiasHigherDefenceOrganization_aprakash, (May 2009).

[489] Praveen Sawhney, "Bombed," *Force,* (February 2004), p. 10; Bharath Karnad, "Maturing Nuclear and Missile Capabilities," *India's Nuclear Policy,* (New Delhi: Pentagon Press, 2008), pp. 94-95.

In the immediate aftermath of the 1998 nuclear test-series India's national security managers were primarily concerned with addressing the question of New Delhi's role in the post-Cold War world order. As India's then national security advisor (NSA) Brajesh Mishra recalls, he was most affected by the Soviet Union's collapse in the early 1990s, the absence of any specific role for India in the new US-led global order and the Indian economy's structural weaknesses in staking India's nuclear claims. As he put it, the "the new world order…India's defense and economic security…these were the three things on my mind…the justification for the tests, whatever you want to call it…is this."[490] It is therefore no surprise that Mishra and foreign minister Jaswant Singh devoted most of their attention to managing the fallout of the nuclear tests, India's relationship with the United States and other great powers and seeking an end to the sanctions regime.[491]

This precedence of political over operational goals became evident from their general disinterest in addressing weapons-related technical and organizational challenges during 1998-2003. Within six months of the 1998 tests, the DRDO issued an internal report to the government confirming what many outsiders suspected, that the thermonuclear device had indeed been a fizzle.[492] However, instead of appointing an internal scientific commission to investigate those claims, advise the government independently, and resume nuclear testing to validate the weapon design, the NSA quashed the controversy by accepting assurances from

[490] Mishra, interview with author.

[491] See Indian foreign minister Jaswant Singh's account in, *In Service of Emergent India: Call to Honor,* (Bloomington: Indiana University Press, 2007), pp. 231-306.

[492] "The Myth Bomber: Interview with K. Santhanam," *Outlook India,* (October 5, 2009), http://www.outlookindia.com/article.aspx?262027, (November 2009).

BARC's hierarchy that test data matched the government's public claims of success, thereby obviating the need for any further tests and a political confrontation with the US.[493]

Between 1998 and the outbreak of Kargil War in 1999, the NSA and his team in the PMO did not apply themselves to addressing the challenges of operational planning either. They brought with them a political understanding of nuclear weapons and disdained the military's attempts to jumpstart the operational process. That latter process, in their mind, would be sequential. It would follow the resolution of political problems on the table that consumed the decision-makers immediate attention. Within months of India declaring itself a nuclear weapon state in 1998 for example, the Chairman, CoSC, General Ved Malik proposed the creation of a tri-service command, the National Strategic Nuclear Command, to centralize the "custodial, maintenance and training responsibilities" of India's nuclear forces.[494] However, the government chose to ignore the proposal. Mishra later explained: "It is always in every country…that the armed forces want to get involved in decision-making etc. etc., even on matters that are strictly political…as far as decision-making is concerned…even there they want to participate… we were very clear about a strict division…that they won't interfere in this process."[495] Nuclear planning therefore remained in the pre-1998 groove, confined to small network of scientists and bureaucrats.

Which is why when the Kargil War broke out in the summer of 1999, and the spotlight turned to the nuclear issue, the government found itself scrambling to get tactical operational planning with the air force off the ground. A senior Indian defense official privy to this

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[493] Ibid.

[494] Manvendra Singh, "Who Should Control India's Nuclear Button? Armed Forces Have a Proposal," *Indian Express*, (September 1, 1998).

[495] Mishra, interview with author.

effort disclosed to the author that until then, the air force had no idea: (a) what types of weapons were available; (b) in how many numbers; and (c) what it was expected to do with the weapons. All the air force had was delivery capability in the form of a few modified Mirage 2000s. At that point, only the air chief, the vice air chief and two other individuals at Air Headquarters had knowledge of the program.[496] The official went on:

> "My educated guess is that a directive to bring the military in the loop may have been issued by the prime minister's office. However, given that nuclear decision making until then was confined to the prime minister and a small set of officials in BARC and DRDO, the directive may have languished. Or alternatively, the prime minister and his top aides may have been told that the air force was in the know…without their understanding that tactical operational planning requires information sharing, coordination, and planning on an entirely different level. Politicians sometimes focus on the big picture and don't pay sufficient attention to details…"[497]

But neither the Kargil episode nor the near war with Pakistan in 2001-02 prodded senior policy planners into rushing institutional decisions. For example, the Arun Singh task force on higher defense management, 'Task Force on Management of Defense', completed its report in September 2000. It was submitted to the government as part of the final GoM recommendations on 'Reforming the National Security System' in February 2001.[498] It proposed reforms in the context of the revolution in military affairs and India's status as a nuclear weapon state. The heart of its recommendations concerned replacing the existing

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[496] Senior defense official 'A', non-attributable interview (2) with author.
[497] Ibid.
[498] Prakash, "India's Higher Defence Organization: Implications for National Security and Jointness."

Chiefs of Staff Committee (CoSC) system with an Integrated Defense Staff (IDS) led by a Chief of Defense Staff (CDS). Prior to the reforms, joint planning between the services was the province of the CoSC, which consisted of the three serving service chiefs. The chairmanship of the CoSC devolved by rotation on the most senior serving chief. But chairmanship of the CoSC did not signify the principle of 'first among equals'. Nor did the three service chiefs and their services coordinate hardware acquisitions, doctrine development and operational plans with each other.

The net result of such institutional practices was the near absence of hardware and operational synergy between the services. Nuclearization created an even more acute operational dilemma because of India's institutional legacy of maintaining a de-mated force. In India, the control of nuclear warheads is divided between two civilian scientific agencies: BARC and the DRDO, which control the fissile cores and non-nuclear firing assemblies respectively. However, the air force, the army and navy each retain separate control of nuclear-capable combat aircraft, ships and ballistic missiles. The protagonists of military reform therefore sought to recast military institutions to instill greater coordination and joint planning between the services.

Compared to the past where the Chairman, CoSC was only a nominal head, the Arun Singh Task Force conceived the CDS as the 'first among equals'. With assistance from a Vice Chief of Defense Staff (VCDS) and the IDS acting as his secretariat for staffing functions, the CDS would "administer the strategic forces" and "provide single point military advice to the government."[499] Pursuant to the Singh task force's recommendations, the government

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[499] Prakash, "India's Higher Defence Organization."

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instituted the IDS in 2001. A tri-service Strategic Forces Command (SFC) to coordinate and manage nuclear forces was subsequently instituted within the IDS in May 2002. However, it wasn't until 2003-04 that the military actually gained institutional authority in nuclear force planning and management alongside the scientific agencies.[500]

SEE *SCHEMATIC 3* FOR ORGANIZATIONAL CHART OF INDIA'S HIGHER DEFENSE MANAGEMENT

Learning in any system depends on the incorporation of new knowledge into existing institutional practices. The incorporation of new knowledge in turn requires input from professionals who staff organizations. In the nuclear as in the conventional sphere, the military's staffing role is absolutely essential in creating strategic and operational knowledge.[501] In the strategic sphere fall numbers, weapon types, targeting and planned use of weapons, command control, and standard operating procedures. In the operational sphere fall logistics, the physical infrastructure needed for support, security, staff requirements, personnel training and exercises to test the force's response in the field. Personnel training and actual field exercises under simulated attack conditions are vital to generate data to assess the viability of existing SOPs and the agencies' response under stress conditions. Such exercises are also the means for generating critical data on the user-machine interface, a process that helps identify and eliminate technical and operator errors.[502]

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[500] Sawhney, "Bombed," p. 10; and Karnad, *India's Nuclear Policy*, pp. 94–95.

[501] Rear Admiral (retd.) Raja Menon, interview with author, New Delhi, March 2009, New Delhi, India.

[502] Koithara, "Hardware to Forces," *Managing India's Nuclear Forces,* pp. 154-155.

However, India's case suggests that many strategic decisions preceded the SFC's institutionalization. "By that time (the SFC's formation)," the former NSA Brajesh Mishra informed the author, "we had decided how much we were going to do…we had decided…not exactly…but somewhat…approximately…the mix of the two kinds of weapons…nuclear (fission)…thermonuclear…having done that at the political level…then we began to think of a nuclear command authority."[503] In February 2004, the unusually well informed editor of the Delhi-based *Force* magazine, Pravin Sawhney, reported on the basis of interviews with Air Marshal Asthana, then C-in-C, SFC, that the SFC had been unable to "find a location for its headquarters and role in the employment of nuclear weapons."[504] Asthana also complained that the SFC's staffing requirements were generally unmet and that the government had not made budgetary provisions for technical infrastructure projects such as hardened facilities and bunkers, secure communications, and secure sites for nuclear delivery vehicles. Among the unknowns at the time was how long it would take India to transition from a peacetime recessed to a force employment mode because the agencies involved - the SFC, the air force, BARC and DRDO – had not practiced drills together. Even as late as 2004, the government had not institutionalized the division of authority and responsibilities among the agencies on general release procedures for the deployment, arming and firing of nuclear weapons.[505] As Mishra put it to the author: "…of course, they (the military) were also very keen about who will give the orders…how will the orders be communicated etc. etc. But…we did not have the time to do anything because we lost the elections and we left."[506]

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[503] Mishra, interview with author.
[504] Sawhney, "Bombed," *Force*, p. 9.
[505] Ibid., p. 10.
[506] Mishra, interview with author.

Since the middle of the last decade, however, the SFC's organizational presence within India's nuclear planning has grown substantially. Former C-in-C, SFC, Rear Admiral (retd.) Shankar volunteered to the author that the SFC's staff strength was a "little below 100." This is a "large staff for a command, especially when compared to other conventional operational commands, where staff strength does not exceed 50-60," he explained. With organizational expansion, the SFC now has departments that cover logistics, a works department for building infrastructure, a technical section that has representation from all three services, a department of land, air, and sea vectors responsible for generating SOPs for the various stages of operational readiness in peacetime and war, an electronics department that focuses on general release codes for nuclear weapons, general computing and communications requirements for the NCA, an independent intelligence analysis group that processes raw data from various government agencies, and its own specialized medical staff.[507]

The SFC's sustained institutional presence over a decade signifies the formal institutionalization and expansion of a military-centered nuclear epistemic community within the state. However, institutionalization alone says nothing about an organization's strength or effectiveness. In the case of the SFC, two factors undermine its institutional strength. First, in the absence of a CDS, the SFC lacks effective command. In the CDS's absence, the chairman, CoSC is responsible for all command and staff functions. However, the position of chairman, CoSC devolves by rotation on the senior most serving service chief at any given time. The Chairman, CoSC's term can last a year or more or simply a few months. For example, India had a succession of four Chairmen, CoSCs between August/September 2004 and February 2005. Similarly, during 2006-2007 there was a succession of three Chairmen,

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[507] Shankar, interview (2) with author, August 2010, New Delhi, India.

CoSC within a span of 10 months.[508] Such rapid rotation brings enormous discontinuity to the task of governing the nuclear force.

Further, the Chairman, CoSC is first and foremost a service chief. He is responsible for command and staff functions in his own service (army, navy, air force). According to Admiral (retd.) Arun Prakash, who served as Chairman, CoSC for an unusually long 20 months during 2005-06, the Chairman, CoSC is barely able to devote "10-15 percent of his time" to the SFC.[509] Further, despite his seniority, the Chairman, CoSC is only nominally the head of the CoSC. The CoSC works by consensus and abides by an informal institutional rule that no service chief will interfere in the functioning of another service.[510] This has created a huge coordination bottleneck for the SFC because the air force, army, and navy each have independent control over the nuclear delivery vehicles. The SFC's C-in-C is a three star officer and junior in rank to the four star service chiefs. He therefore cannot command them or their service to do his bidding. He must of necessity operate through the Chairman, CoSC, who in the first instance is unable to devote full time attention to the SFC and in the second is bound by informal institutional rules that favor consensus and non-interference in each service's affairs.[511]

Other problems arise because of the SFC's isolation within the tri-service IDS, the agency in which it is institutionally situated. The IDS serves as the secretariat for the CoSC. It houses all joint commands and is the agency responsible for all inter-services planning and

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[508] Admiral (retd.) Arun Prakash, "9 Minutes to Midnight," *Force*, (July 2012), p. 4.
[509] Prakash, interview (1) with author.
[510] Admiral (retd.) Arun Prakash, "India's Higher Defence Organization: Implications for National Security and Jointness."
[511] Prakash, Bhavnani and Shankar, interviews with author.

coordination functions. In theory, senior Indian military leaders grouse, the IDS should

perform all the SFC's staffing and infrastructure development functions and leave its

commander with only strategic planning and command duties. However, although the SFC

is formally a part of the IDS, "there is no link between the two," according to a former SFC,

C-in-C. "The SFC reports to the Chairman, CoSC."[512] As a result, the IDS is unable to

synergize tasks with the SFC. Similarly, conventional and nuclear operations under the

current dispensation are the independent responsibilities of the three services and the SFC.

Coordination is only possible through the CoSC or the IDS.[513] The first is weak. The latter is

questionable. Planning and operational problems at the CoSC-level concerning the SFC

therefore require resolution by the NSA or his deputy in the PMO, a process that

marginalizes the defense minister. The SFC essentially directly functions under the PMO

through the NSA, bypassing the defense ministry and the military's normal chain of

command.[514] Its command system, as two former C-in-Cs, SFC and Chairmen, CoSC

reiterated to the author, "is broken!"[515]

Not only is the SFC's institutional position weak, other limitations also truncate its ability to

induce fresh nuclear learning within the state. As argued earlier in the dissertation,

institutional effectiveness depends on an epistemic community's ability to generate new

consensual knowledge. As a second step, the epistemic community must have the

institutional power to inject that consensual knowledge into the state's existing habits to

change them. The development of new consensual knowledge depends first and foremost

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[512] C-in-C, Strategic Forces Command, 'P', non-attributable interview (1) with author, April 2009, New Delhi, India.
[513] Ibid.; Bhavnani, interview (1) with author.
[514] Koithara, "India's Nuclear Force Management System," *Managing India's Nuclear Forces*, pp. 175-176.
[515] Shankar, interview (1) with author.

on information turnover and exchange. Information is the fundamental means that professionals use for performing "truth tests" and growing a society's knowledge banks. Prior to 1998, this was impossible because information was hived off in a tiny social network consisting of scientists and bureaucrats who even today boast that they will "carry India's nuclear secrets to their grave."[516] But in the post-1998 decade, the Indian military has access to sensitive information about the hardware and operational issues. This has provided it the means to challenge both the scientific "strategic enclave" as well as political decision-makers.[517] However, as the next two sections show, the military's ability to extract credible commitments from both is seriously limited. This latter condition places bounds on the nuclear force's operational effectiveness.[518]

The Shift From Heuristics to Structured Decisions and Planning

Non-institutionalized decision-making and planning in the first half of last decade and the weak institutionalization thereafter, once again show why operational outcomes in India exhibit signs of uneven optimization. Without doubt, Indian leaders in the last decade committed themselves to 'expanding' and 'interconnected' goals. However, they did not immediately match those goal commitments with a simultaneous resolve to building strong institutional capacities. In the latter's absence, their decisions from the first half of the decade corroborate many of the fundamental insights of the Cybernetic and Cognitive approaches: sequentialism, loose coupling, and the use of simple heuristics. Instead of drawing on blueprints to guide policy, they followed their gut instincts to make

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[516] Senior defense official 'X', non-attributable interview with author.
[517] Prakash and Shankar, interviews with author.
[518] Bhavnani, interview (1) with author.

determinations. Often, their measures of optimality were not consensually determined scientific or management benchmarks but internally held values and belief systems.

Many early decisions, especially those concerning nuclear warhead lethality for example, have had a path dependent lock down effect that rule out optimization. This has had a negative impact on strategic force planning. Barring the complete upending of the status quo, optimization is now only possible at the margins through improvements in the reliability of delivery systems. However, the military's gradual institutionalization in nuclear policy planning has created the organizational foundation for problem decomposition, parallel processing, and the substitution of simple heuristics-based assumptions with strategic judgments based on operations research. Thus some optimization has followed in the operational management of the nuclear force. There is now greater emphasis on inter-agency planning. Actions are more coordinated between them thanks to new common operating procedures. Military exercises have also revealed logistical vulnerabilities in the transition from peacetime to wartime alert. Some procedural modifications have been instituted to address them. The military is also using the logistical demands of the sea leg of the triad to push civilian decision-makers to substitute institutional (negative) for the operationally more efficient procedural (positive) controls, with some success. However, India's higher defense management problems have dichotomized conventional and nuclear operations. This raises questions about the degree of optimization possible at the aggregate level of warfare.

When designing a nuclear force, planners think in terms of damage expectancy (DE) to enemy targets. Numerical estimates of nuclear warheads and delivery systems flow from this fundamental calculation. DE is the product of the probability of target kill, air defense

penetravity, pre-launch survivability of the weapon system and its reliability. Among these probabilities, target kill and reliability of the weapon system form the core concerns of professional planners. Target kill substantially depends on the nuclear warhead's yield (lethality) and it reliably producing that yield every time it is exploded.[519] However, evidence from India's 1998 nuclear tests has raised serious concerns about the upper yield limits and reliability of its warhead designs.[520] Further, the political management of the technical controversy that arose in the wake of those tests compellingly shows that simple heuristics and not rational optimization drove decision-making.

It is now apparent that pre-1998 nuclear weapons design in India was almost the exclusive enterprise of its nuclear enclave with minimal direction from the political leadership and none whatsoever from the military. The political leadership approved the development of advanced nuclear weapon designs such as boosted-fission and thermonuclear warheads without understanding the technical implications of what those weapons might mean for any future force design.[521] Similarly, like with many principal-agent dilemmas that arise from conditions of "information asymmetry," the political decision-makers had little understanding of the technical parameters and demands of a field-testing program to validate designs that BARC had on its shelf. To be sure, the nuclear test window in 1998 was

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[519] Theodore A. Postol, "Targeting," in Carter, Steinbruner and Zraket eds., *Managing Nuclear Operations*. pp. 379-380.

[520] Tellis, "Toward a Force-in-Being (II), *India's Emerging Nuclear Posture,* pp. 498-522.

[521] Indian nuclear scientists privately admit that prior to 1998 nuclear weapons design and development was an autonomous enterprise within the Indian state and one generally bereft of political direction. Dr. P.K. Iyengar, Chairman, Atomic Energy Commission / Secretary, Department of Atomic Energy (1990-1993), interview with author, June 2010, Mumbai, India; Dr. M.R. Srinivasan, Chairman, Atomic Energy Commission / Secretary, Department of Atomic Energy (1987-1990), interview with author, Bangalore, July 2010; also see, Karnad, "Maturing Nuclear and Missile Capabilities and Credible Deterrence Strategy, Post-1998," p. 76; "Hesitant Nuclear Realpolitik: 1966-to-date," p. 321.

determined on the advice the political decision-makers received from their scientific advisors.[522] However, the nuclear scientists, who after 1974 were frustrated by their inability to persuade the political leadership to authorize hot-tests, offered their principals a compressed program of rushed tests to minimize political exposure.[523] The political decision-makers' acceptance of this rapid test series itself rested on a heuristic understanding of the political risk they and India could bear in the ensuing confrontation with the United States.

Among the nuclear weapon designs tested in May 1998 were that of a fission weapon and a two-stage thermonuclear device. The thermonuclear device had a boosted-fission trigger in the first stage, the scientists' goal being to piggyback the boosted fission design on the thermonuclear device.[524] In the immediate aftermath of the first round of nuclear tests on May 11, 1998 itself, the coordinator of the test program K. Santhanam concluded on the basis of preliminary observations of instrumental test data and the crater morphology at the test site that the thermonuclear design had "underperformed."[525] However, the BARC team rejected DRDO's assessments on grounds that the latter's "instrumentation was faulty."[526] BARC, India's principal nuclear design agency, reported to the government after the second round of tests on May 13 that it had achieved all its design and data objectives from the tests.[527] Following this advice, Vajpayee's BJP government declared a moratorium on further testing.

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[522] Mishra, interview with author.
[523] Iyengar, interview with author.
[524] Dr. P.K. Iyengar, "Non-Fissile Doubts," *OutlookIndia,* (October 26, 2009), http://www.outlookindia.com/article.aspx?262331, (November 2009); Tellis, "Toward a Force-in-Being (II), p. 510; Karnad, "Hesitant Nuclear Realpolitik: 1966-To-Date," p. 406.
[525] Santhanam, "The Myth Bomber."
[526] Ibid.
[527] Mishra, interview with author.

Both these episodes, the scientific and its follow up political act, exemplify how the absence of strong institutions and structured decision-making produces sub-optimal policy outcomes with deleterious consequences. With no institution or agency to monitor the scientific agencies, the principals (political decision-makers) had few means to monitor their agents (scientists) performance. The disputing scientific agencies themselves, DRDO and BARC, lacked institutional mechanisms to subject members of the nuclear cohort to "truth tests" before making consensual claims. The consequence was faulty reporting on one of the most sensitive national security matters to the government. Absent any institutional processes to weigh down decision-making, Prime Minister Vajpayee similarly claimed the tests a success and declared a test moratorium almost immediately after without awaiting further triangulation of seismic data and crater morphology observations with post-shot radioactivity measurements. The prime minister, as Indian foreign minister Jaswant Singh later revealed, "…was by instinct placatory…had from the beginning in his public stance been in support of disarmament…there was no bouncing off of ideas with his confidantes…It [the testing moratorium] was an instinctive reaction. It shows up Vajpayee in bad light. But the fact of the matter is the Indian political leadership does not have the tradition of either great study or reflection…"[528]

Within six months of the May 1998 tests, the DRDO issued a classified report to the government, which raised doubts about the reliability of the thermonuclear design. In response, then NSA Brajesh Mishra summoned a meeting of the DRDO and BARC representatives to discuss the report's findings. But at the end of it, he squelched the debate

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[528] Cited in, Karnad, "Maturing Nuclear and Missile Capabilities," p. 70.

by saying the "government would stand by Dr. Chidambaram's [BARC] opinion." Mishra's account of the episode is telling. As he put it to the author:

"…the funny thing is the pressure to test came from these very scientists. So when finally in '98 we said: go ahead and do it…I asked them how long would it take to test…these scientists who had weaponized…they were the ones who were insisting that there must be tests…and we wanted to do it openly…and then declare ourselves as a nuclear weapon state.

So…the scientists…and there must have been many involved…but the five I know are Dr. Chidambaram, Kakodkar…Sikka…from BARC and Kalam and Santhanam from DRDO…now when they went in for the tests they told me that they wanted to do six. We can't do it one day…we need two days. First day they tested three; and then two days later they wanted to test another three. But after the fifth one, they telephoned me and said we don't need another one. We have all the data that we wanted. They said the tests are successful…the weapon design is proved.

…a couple of months later [after the May 1998 tests] Dr. Kalam and Dr. Santhanam came to see me…and it was Santhanam who said that they had doubts about this…and we need to do something about this. And I asked: we need to do what? We have declared a moratorium… So I said: you have doubts…I will call the people from Bombay…let's sit down and discuss the matter. You raise the doubts and let them reply. So I called a meeting with the five of them …so Santhanam gave his reasoning...The three of them (BARC team) gave their replies. More particularly, Sikka

who was the man intimately involved with the design came out with a long

explanation…giving this detail…that detail. I said ok…the meeting ended."[529]

When asked why he did not appoint a scientific commission comprising retired nuclear

scientists and weapon designers to review the DRDO's findings and render independent

advice to the government, Mishra replied:

> "We tested five times…apart from 1974. In '74 when the test was done…nobody came
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> out and said: we want a review…whether the test was successful or not successful…the
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> point I am trying to make to you is: if we don't trust those very same people who were
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> insisting upon tests….I mean the political leadership never went to them and asked
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> them to test…it was they…the scientists…who for years had been insisting on
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> testing…at least for 10 years…so then you appoint a review committee to verify the
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> results? I mean this is a strange logic….a review committee also means giving up your
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> secrets…whatever you have."[530]

The above account, if accepted literally, is the clearest evidence of the triumph of "faith

based politics" over any countervailing notions of rationality. In order to maintain the

internal simplicity and consistency in their decision-making, Indian decision-makers chose

pre-formed beliefs over institutionalized "truth tests" to resolve uncertainty in an issue area

where they lacked credible knowledge. Their approach was, as Santhanam observed years

later: "I have made up my mind, don't confuse me with facts."[531] An alternative explanation

is that the political decision-makers simply decided that it wasn't worth the trouble to

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[529] Mishra, interview with author.
[530] Ibid.
[531] Santhanam, "The Myth Bomber."

validate the thermonuclear design through a program of further tests as the latter decision

would further inflame the United States and burn more political capital. Perhaps the

politicians decided the 20-30kt-fission weapon, which had "worked like a song"[532] in 1998,

would suffice for purposes of deterrence. In fact, during the thermonuclear weapon

controversy, which erupted in 2009 when Santhanam went public with his claims, the former

scientific advisor to the defense minister V. S. Arunachalam argued that deterrence "is…a

mind game" and simple Hiroshima-type devices would be sufficient to kill people in the

hundreds of thousands. It therefore would not matter if India lacked a reliable

thermonuclear warhead with a scaled up yield of 150kt.[533]

If this latter reasoning were the decision-makers' private justification for foregoing any

further testing, then it would once again point to the prevalence of satisficing over

optimization in Indian policy planning. The 150kt thermonuclear design, or the boosted-

fission weapon, if part of the mix of warheads that make up India's nuclear force, will always

remain dogged by uncertainty.[534] The yield reliability of the thermonuclear device's boosted-

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[532] Ibid.

[533] K. Subrahmanyam and V.S. Arunachalam, "Deterrence and Explosive Yield," *Hindu,* (September 2009), http://www.thehindu.com/opinion/op-ed/article22870.ece, (October 2009).

[534] According to Dr. M.R. Srinivasan, former Chairman, Department of Atomic Energy (1987-1990): "…without more tests the reliability of the 20kt fission device is 100 percent," the tritium-boosted design, "it will surely work…there will be a bang! But the full performance of the booster part will be subject to less than 100 percent surety…in the case of the full thermonuclear device the confidence will perhaps be less." Cited in Karnad, "Maturing Nuclear and Missile Capabilities," p. 68. The Indian Department of Atomic Energy claims that it is capable of building "fission and thermonuclear fusion weapons from low yields up to around 200 kilo tones (kt)." See, "Pokhran-II tests were fully successful; given India capability to build nuclear deterrence; Dr. Kakodkar and Dr. Chidambaram," DAE Press release No. 52820, (September 25, 2009), http://pib.nic.in/newsite/erelease.aspx?relid=52820, (October 2009).

fission trigger is also uncertain.[535] Assigning these designs reliability probability estimates in

the absence of full-scale 'hot' tests carries high risk. This essentially means that the

foundation for determining the size of the nuclear force is arbitrary and unscientific because

the reliability of the thermonuclear design and its boosted-fission trigger cannot be

determined with accuracy. On the other hand, the alternative solution of building a nuclear

force centered on 20-30kt fission weapons imposes significantly higher performance and

reliability demands on weapon carrier systems such as ballistic missiles.[536] The absence of

this understanding early on suggests that Indian political decision-makers harbored a simple

heuristics-based understanding of nuclear force planning; and that the lack of structured

planning and oversight in India's nuclear decision-making processes in the first half of the

last decade has created negative path dependencies without the policy makers even

comprehending the deductive consequences of their decision.

Unlike the US, India until recently did not have the institutional equivalent of a JASON

Committee[537] to independently advise the government on the science and engineering of

nuclear weapons. Senior members of India's nuclear weapons design establishment such as

former AEC Chairman Dr. P.K. Iyengar have admitted that in the past the federal

government's technical and non-technical proxies who sat on the AEC's board lacked both

information and knowledge to undertake any meaningful audit of BARC's performance.[538]

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[535] Ibid.
[536] Koithara, "Nuclear Hardware," pp. 129-130.
[537] JASON is an independent advisory panel that provides consulting services to the US Government. It was formed in 1960. For JASON reports see, "JASON Defense Advisory Panel Reports," *Federation of American Scientists,* http://www.fas.org/irp/agency/dod/jason/.
[538] Iyengar, interview with author; for an excellent analysis of the principal-agent problem concerning the Indian political executive and the Department of Atomic Energy see, Buddhi Kota Subbarao, "The Darkness Surrounding That Day In The Desert," *OutlookIndia,* October 5, 2009, http://www.outlookindia.com/article.aspx?262028, (November 2009).

Indeed, the 1998 test episode is evidence of the limits of even DRDO's auditing capacity, the one government agency responsible for weaponization. Because the military was never part of the nuclear design effort and is a consumer, it remains a vehicle for transmitting scientific dissent and not independent oversight.[539] There until the thermonuclear weapon test controversy exploded in public, there were no guards who could exercise effective oversight over India's nuclear guardians, a condition that imposed institutional limits to any nuclear learning in the system.[540]

Force posture development in the first half of last decade also suffered from the cognitive dissonance among the handful of decision-makers who in 1998 proclaimed India's nuclear status but then did not follow up their act by building state agency to leverage that capability. However, changes in operational procedures since 2004-05 suggest that some optimization has followed the intervention of the SFC and the higher military command. From 1998 until at least 2003, Indian leaders retained the institutional legacy of the pre-1998 era: the de-mated and distributed posture, which Tellis summed up as "strategically active" but "operationally dormant" in peacetime.[541] Control of the arsenal initially remained devolved upon the pre-1998 network of scientists from BARC and DRDO. This path dependent pattern partly stemmed from high-centralization, a condition which imposes limits on the human attention span. Absent the offsetting impact of institutionalized decision-making that

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[539] Karnad, "Maturing Nuclear and Missile Capabilities," pp. 69-70.

[540] According to former Indian Foreign Secretary Shyam Saran and currently Chairman of the National Security Council Advisory Board, some of these oversight problems have been rectified through the institutionalization of a Strategy Program Staff in the PMO with representatives from all scientific agencies and the armed services to advise the NSA. See Shyam Saran, "Weapon that has more than symbolic value," *Hindu,* May 4, 2013, http://www.thehindu.com/opinion/lead/weapon-that-has-more-than-symbolic-value/article4681085.ece (May, 2013).

[541] Tellis, "Force-in-Being," pp. 367-467.

enables problem decomposition and parallel tasking, it nudged decision-makers into the state's habitual mode of resolving problems in the sequence in which they presented themselves. But it also owed much to the decision-makers' unchallenged heuristic conditioning drawn from the analogy of the superpowers' Cold War nuclear competition, which equated operationalization with higher force alerting and the subsequently greater likelihood of nuclear use due to inadvertence or accident. Thus in the first five years after the 1998 tests, decision makers remained focused on the first-order political problems stemming from India's overt nuclear status, while inter-agency coordination problems pertaining to operational planning languished. As a consequence, the friction between operational dormancy and operational employment modes proved stickier than policy makers had imagined.[542]

As Clausewitz famously observed, "everything in war is simple, but the simplest thing is difficult." Indeed, the 1999 Kargil War and then the 2001-02 military mobilization against Pakistan empirically demonstrated just how hugely complex the task of nuclear force reconstitution and employment readiness was in the absence of well-developed inter-agency management structures and protocols.[543] In 1999, there was no "common knowledge base" to establish a "common operating base" between the scientific agencies and the air force. The scientific agencies had assumed for example that 72 hours was a reasonable time window within which the nuclear force could transition from recessed to employment mode. However, according to a senior participant in the planning process, it took "nearly a week" before the air force and the agencies were able to "make the weapons operational."[544]

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[542] Prakash, interview (1) author; Karnad, "Maturing Nuclear and Missile Capabilities," p. 93.
[543] Ibid.
[544] Senior official 'A', non-attributable interview with author.

Members of the nuclear network had to orally ratify all actions in the absence of institutionalized standard operating procedures, a process that added to the logistical friction.[545] The 2001-02 standoff with Pakistan similarly demonstrated that the de-mated operational posture while "politically correct" was "operationally hazardous."[546] Due to the SFC's delayed institutionalization, inter-agency operational procedures remained inchoate. The absence of joint drill and training exercises involving all agencies on the ground meant that the alerting procedures and timelines were still paper exercises. The military also found the alerting and readiness procedures put together by BARC and DRDO to be cumbersome and overly optimistic.[547]

Among the military's first tasks post-2002 was to formalize SOPs and institutionalize operational planning with the civilian bureaucratic and scientific agencies. In December 2002, the government adopted the 'Red Book', a highly classified document that "contains the nuclear doctrine plus certain additional standard operating procedures…various chains of command, succession lists…and deals with various contingencies…"[548] After its formation in 2003, the SFC institutionalized meetings with the scientific agencies to coordinate nuclear planning at regular "two month intervals."[549] By 2004, the SFC submitted for government approval operational plans pertaining to nuclear release codes.[550] It similarly

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[545] Ibid.

[546] Karnad, "Maturing Nuclear and Missile Capabilities," p. 93.

[547] Sawhney, "Bombed," p. 10.

[548] Prakash, interview (1) with author. According to a senior SFC officer who spoke to the author on condition of anonymity, a committee led by K. Subrahmanyam prepared the 'Red Book' in September/October 1999.

[549] C-in-C, Strategic Forces Command, 'P', non-attributable interview (1) with author.

[550] Mishra, interview with author; Sawhney, "Bombed," p. 10.

prepared the 'Blue Book', a lower order set of classified instructions that detail procedures at the unit level of the armed forces with regards to nuclear weapons.[551]

Subsequent SFC-led military exercises revealed the difficulties of transitioning from peacetime to a readiness posture. A major logistics challenge was the simple movement of missiles and nuclear warhead components to pre-designated mating and launch locations because of India's urban congestion and poor road and rail infrastructure. The military concluded that the logistical drag on the force, especially in the aftermath of a nuclear strike, could reach a tipping point sufficient to disrupt any retaliatory response.[552] It also discovered that many of the de-mated force's components were stored in conditions that left them vulnerable to pre-emptive attacks.[553] The SFC drew on these lessons along with those from the 1999 and 2001-02 military mobilizations to vacate missiles and nuclear ordnance out of urban bases to the rural hinterland.[554] It also prevailed upon the government to streamline nuclear alerting protocols and reduce the procedural steps to deploy the arsenal in an operational mode from six to four. Under the new protocol, the first stage of nuclear force alerting will begin simultaneously with any conventional mobilization. Nuclear weapons will be armed in the first stage itself. In the second stage, the weapons will be dispersed. The third stage will involve mating the weapons with delivery systems. The role of the scientific agencies will end at the third stage and firing authority will devolve upon the military in the fourth and final stage.[555]

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[551] Bhavnani, interview (2) with author.
[552] Prakash, interview with author; Karnad, "Maturing Nuclear and Missile Capabilities," p. 103.
[553] Ibid., p. 97.
[554] Ibid., p.103.
[555] Ibid., pp. 95-96.

Beginning from the middle of the last decade, there is clear demarcation of dual-use delivery systems and their crews in the armed services to deal with the problem of crosscutting authorities. Under the new procedures, these assets are "quarantined" and placed under the SFC's command during training exercises and wartime alerting.[556] In peacetime, the arsenal still retains its de-mated form. But underneath that broad institutional tent, smaller procedural changes have begun to erode some of the earlier civilian reticence concerning positive controls. As the C-in-C, SFC, Air Marshal (retd.) Bhavnani put it to Bharath Karnad, "it has been time consuming for political bosses to understand what's a de-mated situation, what's a mated situation, why we should have a mated situation. But once they were made to understand, we are now in a good situation."[557] Thus for example, some types of nuclear ordnance is now co-located with delivery vectors at air and naval bases.[558] In the navy's case, the separation is more apparent than real. Thus, the two naval warships, which constitute the sea-leg of the triad, will sail with ballistic missiles and nuclear ordnance on board during operational alert.[559] The political leadership retains institutional separation and control through representatives of the scientific agencies on board the ships. However, for all practical purposes the navy has command of the nuclear force.

Affirming that political decision-makers had indeed begun to appraise operational postures on land and sea differently on the basis of their logistical and operational demands, the former NSA Brajesh Mishra candidly explained to the author:

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[556] Shankar, interview (2) with author.
[557] Karnad, "Maturing Nuclear and Missile Capabilities," p. 99.
[558] Ibid.
[559] Koithara, "Nuclear Hardware," p. 137.

"You have to make a difference between the navy, the air force, and the missiles on land. When the admiral…is out…hundreds of miles away, he must have those weapons with him…but there must be a way of communication between the submarine or the ship and the decision-makers in Delhi whether to fire or not to fire. But in the case of [the] air force, unless they are on an aircraft carrier…that's a different matter. But with land based missiles that is not the same question…"[560]

In a similar vein, technology and not the overall tenor of civil-military relations has become the critical driver behind the trend favoring delegated or positive command and control in at least the naval leg of the Indian military. The "concept of a 'force-in-being' with physical separation between vector, the fissile material, and non-fissile assemblies is a thing of the past," the C-in-C, SFC, Rear Admiral (retd.) Shankar insisted to the author. "Technology has intervened in the process," he emphasized. "Consider the nuclear submarine…the missiles will be encapsulated on board the vessel. You can't then separate the warhead from the missile. The implications of all this being that 'procedural' separation must replace 'physical' separation in the various states of operational readiness."[561]

In the last decade, therefore, there has been a steady stream of operational improvements at the procedural tactical level of force employment. However, optimization has eluded the Indian military at the aggregated level of nuclear and conventional operations. This is in part a legacy of the development trajectory of India's nuclear weapons program. In the pre-1998 era, there was no institutional link between the scientific agencies that designed and built

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[560] Mishra, interview with author.
[561] Shankar, interview (1) with author.

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nuclear weapons and the services.[562] Neither did the government task the services with developing an epistemic community in the realm of nuclear strategic thought and warfare. Services such as the army have an NBC directorate.[563] But its task is defensive and not offensive operations. According to a former Chairman, CoSC, Admiral Prakash, "A start was made in 2005 [for the SFC], but till then our military training and courses had no component of nuclear war fighting…NBC protection and all that is there…but not even an academic study of the theories and doctrines of nuclear war fighting is there…the military is not encouraged to study nuclear war fighting doctrines…"[564] This same individual who presided over the management of India's nuclear forces for nearly two years in 2005-06 recently confessed his ignorance on matters nuclear at the inception of his tenure. In his own words:

> "…a few days into my tenure, when the C-in-C, SFC came to make a formal call, his allotted 15 minutes stretched out to over an hour; because I found to my consternation, that much of what he wanted to discuss was alien to me. Apart from re-reading some long forgotten principles of physics, I spent many weeks poring over the works of analysts like Perkovich, Tellis, Karnad, and Menon to learn about India's evolution as a nuclear weapon state (NWS), and trawling through the writings of Brodie, Gray, Wohlstetter and others, to comprehend the arcane nuances of deterrence theory. It was exasperating to find that after 39 years in uniform, the system had ill prepared me for the most critical responsibility that I was to ever shoulder; but equally galling was the realization that the time I devoted, as Chairman, CoSC, to the nuclear deterrent would be at some cost to India's maritime security – my primary commitment as naval

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[562] Iyengar, interview with author.
[563] Oberoi, interview with author.
[564] Prakash, interview (1) with author.

chief."[565]

Post-1998, all nuclear operations have devolved upon the SFC. The act of cordoning off the SFC within the IDS, which is the secretariat and coordinating arm of the CoSC, has institutionalized the conventional-nuclear dichotomy. Similarly, the service headquarters exclusively concern themselves with conventional war; and no higher defense learning institution imparts training to military officers on nuclear strategy and operations. "The service headquarters," according to Admiral (retd.) Prakash are "ill prepared for the conduct of operations of this nature and none of them have been asked to create a branch, directorate or even a cell dedicated to [the] conduct of nuclear warfare or for evolution of related doctrine."[566] The CDS at the head of the IDS was to be the coordinating link between nuclear and conventional operations. But as discussed earlier, with the government's failure to appoint a CDS, these coordination tasks have fallen to the Chairman, CoSC and the CoSC, both infirm coordinating institutions in the military.

Civilian decision-makers take their cue from a heuristic understanding of nuclear weapons -- such weapons produce a big bang and kill lots of people. They tend to see such weapons in a largely dichotomous and genocidal role. However, senior military leaders in the SFC and CoSC view sub-conventional, conventional and nuclear operations part of a single spectrum of operations. They believe that low-yield tactical nuclear weapons, which China and Pakistan possess, could be used for strategic political effect on the battlefield with relatively low casualties. Conventional operations could therefore "seamlessly" transition to a nuclear

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[565] Prakash, "9 Minutes to Midnight," p. 4.
[566] Ibid., p. 5.

exchange.[567] A nuclear attack by an adversary, at least in its early stages, would very likely

assume the form of a symbolic strike, a demonstration or warning shot against some tactical

Indian formation in the field.[568]

The risk of Chinese nuclear strikes in the Himalayan theater of operations is generally

considered to be low at present.[569] But this is also, as a former Chairman, CoSC explained to

the author, because India is "…grossly ill-informed about the Chinese military psyche,

thought process, and mind sets…it has failed to devote adequate resources to a serious study

of these factors."[570] More recently, in the last decade, the army's NBC directorate has

conducted internal studies and war-gamed several Pakistani nuclear use scenarios against

Indian military formations on the western border.[571] The latter are considered a more serious

risk because New Delhi's war approach in the last decade has evolved to punish Pakistan for

waging decades-long sub-conventional war against India. The new Indian military doctrine

of fighting a 'limited conventional war under nuclear conditions' proposes offensive and

escalatory albeit shallow conventional operations against Pakistan.[572] The Pakistani counter

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[567] Prakash and Bhavnani, interviews with author.

[568] Shankar, interview (1) with author.

[569] Chairman, Chiefs of Staff Committee, 'R', non-attributable interview (1) with author, July 2010, New Delhi, India.

[570] Prakash, personal communication with author, April 2009.

[571] The Indian army's internal assessments suggest that Pakistani tactical nuclear use would be most likely be in (1) Rajasthan; (2) South Gujarat; (3) Punjab; and (4) Jammu & Kashmir, in the listed order of preference. The Rann of Kutch is another likely area of usage. Senior army officer 'Q', NBC Warfare Directorate, non-attributable interview with author.

[572] Gurmeet Kanwal, "Conventional Operations Under the Nuclear Hang," *Indian Army: Vision 2020*, (New Delhi: HarperCollins, 2008), pp. 62-87; Walter C. Ladwig III, "A Cold Start for Hot Wars: The Indian Army's New Limited War Doctrine," *International Security,* Vol. 32, No. 3, Winter 2007/2008, pp. 158-190.

to this development is the threat of "asymmetric escalation" through tactical nuclear means.[573]

Senior Indian military leaders at the highest levels aver that such attacks, if they do materialize, would demand a highly calibrated Indian counter-response to terminate war at the lowest possible level of nuclear exchange.[574] However, such a nuanced politico-military strategy would be difficult to pull-off given the current state of compartmentalization between India's conventional and nuclear war commands. A decade after the 1998 nuclear tests, India's former army chief General (retd.) Ved Malik publicly raised the question whether the services "had been able to interface… nuclear capability with conventional capabilities…?"[575] To this question, former C-in-C, SFC, Air Marshal (retd.) Bhavnani replied in private that "this compartmentalization still exists…and…we've tried our best…we've said that it is important for everyone in the military to understand the nuclear issues…all I can say from the time…from 2001 till today there has been an evolutionary change in the understanding of nuclear warfare. Prior to 2001 nobody even thought about it…nobody said it is time to sit down and figure out the implications of a nuclear war."[576]

Senior SFC commanders claim that procedures now exist for coordinating conventional and nuclear operations. When India transitions from peace to wartime, "the relevant command and control authorities will simultaneously move into the SFC's operational command posts

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[573] Vipin Narang, "Posturing for Peace? Pakistan's Nuclear Postures and South Asian Stability?" *International Security,* Vol. 34, No. 3, Winter 2009/2010, pp. 38-78.
[574] Chairman, Chiefs of Staff Committee 'R', non-attributable interview (1) with author; Prakash, personal communication with author.
[575] General (retd.) Ved Malik, Army Chief of Staff (1997-2000), "Operation Shakti: A Decade Later," *USI Journal*, Vol. CXXXVIII, No. 572, April-June 2008, http://www.usiofindia.org/Article/?pub=Journal&pubno=572&ano=337, (May 2009).
[576] Bhavnani, interview (1) with author.

and the SFC will retain contact through close physical proximity and real-time communication links."[577] But paper plans and coordinating procedures, they also concede, are weak substitutes for horizontal organizational integration between the SFC and IDS. In the absence of a CDS, the SFC remains an orchestra without a conductor. In any war, the primary focus of the three service chiefs would be on fighting their own separate conventional wars.[578] This will also apply to the Chairman, CoSC, the nominal head of the SFC, who is first a service chief and then the head of IDS.[579] Operational direction of the SFC, they fear, will devolve by default on the NSA, an individual who due to his general foreign service background is untutored in the arts of operational strategy.[580] This situation would be akin to the 1962 border war with China when Prime Minister Nehru and his senior colleagues subverted the military's operational chain of command by literally interfering in troop deployments at the company and brigade levels with disastrous consequences.[581]

Legacy Principal-Agent Relationships and Operational Dilemmas

The most serious problem in India's quest for operational optimization is the lingering path dependency effect of principal-agent relationships from the pre-1998 era. The compartmentalization of information, the institutional separation of the political principals from the military, the lack of agent competition between the military and the scientists and the lack of independent oversight bodies created information asymmetries whose policy effects are now hard to overcome. Those institutional legacies mar both force lethality and the execution of nuclear operations.

[577] Shankar, interview (1) with author.
[578] Prakash, interview (1) with author.
[579] Ibid.
[580] Prakash, Bhavnani and Shankar, interviews with author.
[581] Srinath Raghavan, "Civil-Military Relations in India: The China Crisis and After," *Journal of Strategic Studies,* Vol. 32, No. 1, (February 2009), pp. 149-175.

Public assurances to the contrary, military leaders harbor deep concerns about the reliability of India's tested warhead designs. Critical open-source data analysis of the 1998 tests is one source that feeds their doubt.[582] More importantly, dissenting opinion within the nuclear design establishment has fueled even greater doubts.[583] Several Indian nuclear scientists believe that the thermonuclear design did not achieve "efficient burn" and requires further "hot tests" to be validated.[584] Indeed, there is evidence to suggest that India may have foregone weaponization of the thermonuclear device.[585] The latter's boosted-fission trigger may have been developed into a weapon. However, yield reliability of the boosted-fission design also remains in doubt with some weapon designers and scientists averring that the reliability of boosted designs is more an empirical art and less a science.[586] It is thus entirely possible, as the best open-source analysis of the Indian tests surmised a decade ago, that simple Hiroshima-type 20-30kt fission weapons constitute the core of India's nuclear inventory.[587] But even in the case of the latter, lesser known concerns have surfaced with regards to the reliability of its non-nuclear detonation systems, such as an accurate height burst fuse.[588]

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[582] Admiral (retd.) Arun Prakash, "Riding Two Horses," *Force,* (November 2009), http://www.forceindia.net/arunprakash14.aspx, (December 2009).

[583] Karnad, "Hesitant Nuclear Realpolitik: 1966-To-Date," pp. 431-433; "Maturing Nuclear and Missile Capabilities," p. 69.

[584] Iyengar, "Non-Fissile Doubts"; also see the public protest note to the Indian government by several senior scientists from India's "strategic enclave." Statement By Deeply Concerned Senior Scientists, "On Thermonuclear Weapon Capability and Its Implications for Credible Minimum Deterrence," *Mainstream*, Vol. XLVIII, No. 1, December 2009, http://www.mainstreamweekly.net/article1865.html, (December 2009).

[585] Santhanam, "The Myth Bomber."

[586] Tellis, "Force-in-Being," pp. 520-521.

[587] Ibid., pp. 519-522.

[588] Sawhney, "Bombed," p. 8.

The Indian military finds itself caught between a rock and a hard place. Because of its long institutional isolation from the weapon design establishment, it lacks independent means to force credible "truth tests" on the scientists. On the other hand, it "has no choice" in the words of a former Chairman, CoSC, but to accept what the scientists certify as reliable.[589] The nuclear design establishment has sought to assure the military that warhead reliability can be certified through means of computer simulations, the separate testing of components and sub-systems, and sub-kiloton tests. However, the users remain skeptical that simulations and sub-system tests are a reliable proxy for integrated system tests.[590] They also find dubious claims made by Indian nuclear scientists' that they were able to collect sufficient data for computer simulations and sub-kiloton tests on the basis of a hasty and limited program of just five field tests, especially when other nuclear weapon powers have had to conduct several dozens of tests or even hundreds to achieve similar results.[591] But they have no means to force the issue. According to at least two former Chairmen, CoSC who spoke to the author on the condition of anonymity, "…the military can't go public with these things…but it has expressed its views in laid down channels at every opportunity…it has been done at the highest levels…but…the politicians believe that the existing state of affairs is ok…"[592]

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[589] Prakash, interview (1) with author.

[590] Karnad, "Maturing Nuclear and Missile Capabilities," p. 66.

[591] As Admiral Arun Prakash put it: "I don't think anyone is satisfied. I mean people in the military wonder if five tests are enough for all time to come when other countries have conducted over hundreds of, even thousand, tests of thermonuclear weapons…they needed to do those tests, then are our computer simulations enough?", cited in Karnad, "Maturing Nuclear and Missile Capabilities," p. 69.

[592] Prakash, interview (1) with author; Chairman, Chiefs of Staff Committee 'R', non-attributable interview (2) with author.

Warhead yield limitations and reliability concerns have inevitably shifted attention to the

performance of delivery systems: aircraft and ballistic missiles. Performance, according to

the SFC, is less a problem with aircraft, which remain by far the most reliable and "flexible"

nuclear delivery vectors in India's inventory.[593] Any limitations have to do with the aircrafts'

short-range, which restricts their use to the Pakistani theater of operations; and the

uncertainty surrounding penetravity due to the lethal nature of modern air defenses. An

Indian Air Force study conducted in the early 2000s showed for example that a single

nuclear mission against Pakistan could tie up as many as 60 aircraft to assist the penetrating

nuclear vector, a huge resource drain during a conventional war.[594] Reliability however is a

lesser concern with dual-use aircraft because the entire inventory is imported. In the case of

modifications on the French Mirage 2000 for nuclear missions in the early 1990s, one of the

key constraints had to do with the lack of access to the aircraft computer's source code.[595]

That is presumably no longer the case in the Su-30s that India acquired from Russia in the

last decade.[596]

The air vector's range limitation and vulnerability to air defenses means that long-range

ballistic missiles, land and sea-based, will be India's primary means for targeting China.

However, reliance on simple fission devices has raised the performance and reliability

demands on ballistic missiles. Fission warheads are heavier than their boosted-fission and

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[593] C-in-C, Strategic Forces Command, 'P', non-attributable interview with author.

[594] For example, a typical nuclear task force would include two nuclear-armed aircraft, three to four electronic counter measures escort aircraft, three to four aircraft for air defense and a similar number to suppress enemy ground defenses. A single mission would comprise 15-20 aircraft and at least two or three decoy missions would be planned simultaneously. See, Sawhney, "Bombed," p. 8.

[595] Senior air force officer 'S', non-attributable interview with author.

[596] Air Chief Marshal (retd.) 'O', non-attributable interview (2) with author, February 2010, New Delhi, India.

thermonuclear cousins.[597] Compared to the latter, they also consume more fissile material per unit.[598] Furthermore, their lower yield means that a ballistic missile unit will likely have to deploy multiple independently targetable re-entry vehicles (MIRV) to achieve the same bang that a single thermonuclear warhead would have achieved. More accurate guidance systems must now compensate for lower yields when targeting large urban centers over long distances.[599] In other words, reliance on fission warheads has generated demands for ballistic missiles with greater throw-weight capacity and the development of other challenging technologies.

The trouble arises because India's long-range ballistic missiles suffer from a high launch failure rate. Further, the missiles have not been tested thoroughly. Ballistic missiles incorporate a range of critical technologies: boost, post-boost realignment and spin, stage separation, warhead separation, re-entry and navigation systems.[600] Critical failure of any of these systems individually or in conjunction can cause catastrophic mission failure. In the Indian case, missile tests have been few. The Agni technology demonstrator (TD) flew only thrice during 1989-1994.[601] Similarly, the medium-range Agni II was tested five times between 1999-2011,[602] and the Agni III four times during 2006-2010.[603] Failure rates have been high in the few tests conducted so far. For example, the Agni TD had a launch failure

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[597] Iyengar, interview with author; Shankar, interview (1) with author.

[598] Ibid.

[599] Koithara, "Nuclear Hardware," pp. 129-131.

[600] "Means of Delivery Technology: Theater Ballistic Missiles," Militarily Critical Technologies List, *US Department of Defense* (1998), Part II, p. II–1–10.

[601] "Agni (Technical Demonstrator), *Missilethreat.com,* http://www.missilethreat.com/missilesoftheworld/id.7/missile_detail.asp, (May 2012).

[602] "Agni II," *Wikipedia,* http://en.wikipedia.org/wiki/Agni-II, (May 2012).

[603] "Agni III," *Wikipedia,* http://en.wikipedia.org/wiki/Agni-III, (May 2012).

rate of 33 percent.[604] The medium-range Agni II and III have suffered launch failure rates of 40 and 25 percent respectively.[605] Furthermore, launch successes and failures tell us nothing about the performance of the missiles' other critical systems concerning which data is scarce. Open source reports suggest however that even missiles that launched successfully, some suffered navigation malfunctions.[606] In other words, the failure rate of some Indian ballistic missiles could be as high as 40-50 percent.

The nuclear warhead and missile duo therefore constitute a highly unreliable system, which raises serious questions about the Indian arsenal's credibility. In comparison to the Agni, the US MX ICBM was tested 80 times. Soviet and Russian missiles on average were put through 10-20 tests to establish reliability.[607] The reliability for US nuclear warheads is estimated between 0.99-0.995 percent. Their overall system reliability drops "sharply to between 0.8 and 0.95" percent when mated with delivery systems. In theory, the combined system failure probability (nuclear warhead plus delivery system) decreases with every percentage drop in a delivery system's reliability.[608]

In India's case, the reliability concerns are enormous because the missile systems flown so far were custom built as test-beds for validating technologies. It is generally a rule of the thumb that quality control during the prototype-manufacturing phase is far higher compared to normal assembly line production. There are concerns therefore that unless Indian missile entities master the industrial line production process, systems unreliability will become the

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[604] "Agni (Technology Demonstrator)."
[605] "Agni II" and "Agni III."
[606] Karnad, "Hesitant Nuclear Realpolitik: 1966-To Date," p. 430.
[607] Karnad, "Managing Nuclear and Missile Capabilities," p. 83.
[608] Koithara, "Nuclear Hardware," p. 131.

Achilles heel of the nuclear force.[609] In order to address the reliability gap, the SFC claims it "has… issued general staff requirements for both the vectors as well as nuclear warheads."[610] It has also demanded a larger number of missile tests under realistic field conditions to establish credible reliability baselines. Nonetheless, the scientific agencies have overruled the military in the past. A scientific panel appointed in 2002 to review the problem recommended that statistical analysis of component, subsystem and system testing coupled with "three consecutive" successful flight tests were cumulatively a good proxy for reliability.[611] Due to the gradual institutionalization of agent competition between the scientists and military, problems of force lethality persist.

In light of the significant reliability concerns, the SFC's principal attempt has been to force a change in the methodology for nuclear force planning, warhead and delivery system numbers, from one based on heuristics to one based on robust statistical DE estimates. In the pre-SFC era, it is highly likely that projections of fissile material availability and crude guesstimates for overall systems and pre-launch survivability were the basis for force planning. The former C-in-C, SFC Air Marshal Bhavnani who oversaw the process during 2004-2006 alluded to this reality when he complained:

> "…one of these grey areas in India has always been that civilian control has been so strong over security matters on matters related to strategic security etc., the senior military people do not fit into their scheme of things…when calculating, when strategizing, when coming out with solutions for making nuclear strategy. So in that

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[609] Ibid., 132.
[610] Shankar, interview (1) with author.
[611] Karnad, "Maturing Nuclear and Missile Capabilities," p. 83.

aspect when a person who has less knowledge about nuclear issues, he then feels that perhaps 10 or 15 nuclear weapons are good enough. We do not think so. Whilst we are there making sure that the weapons are ready, the missiles are ready, the platforms are ready…the strategizing is left to somebody else. So in that sense, who decides whether you need a 100 odd weapons or 10 weapons to achieve that deterrence…it is the strategists. The nation's nuclear strategy…should be decided by a group of people who are well informed in this area…who are not there to make short term decisions, but the long term ones."[612]

However, the greater availability of fissile material in the aftermath of the 2005 Indo-US nuclear rapprochement and the deeper institutionalization of the SFC appear to have changed that reality. Senior SFC commanders such as Bhavnani's successor Rear Admiral (retd.) Shankar insists, "Everything is numbers based…on operations research-based probabilistic analysis. The former is necessary to arrive at facts…in contrast to the intuitive gut-instinct analysis of the nuclear scientists, politicians, and their civilian advisors in the past."[613]

Alongside reliability issues, force reconstitution and operational employment remain the SFC's other principal concerns. Whereas problems of force lethality stem from the legacy of the institutional separation between the military and their scientific agents, the problems of operational employment emanate from the institutional isolation of political principals from their military agents. Intrinsically, there are two reasons why senior SFC and other military leaders are uncomfortable India's recessed posture and divided command and control. The

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[612] Bhavnani, interview (1) with author.
[613] Shankar, interview (1) with author.

first has to do with overcoming the challenges of weak physical and organizational infrastructure. The second concerns the slow development of robust operations management practices.[614] India's operating conditions in the past decade have encountered the worst of two worlds: a disaggregated arsenal embedded within weak physical and organizational structures and management practices.

During the mid-2000s for example, the SFC judged the infrastructure invisibles of the Indian nuclear force, especially its communications and transport networks, to be sub-par. "If Pakistan decides to launch [an attack] in such a way that it takes out your command and control…it decides to take out some of your nuclear nodes," asserted former Chairman, CoSC Admiral Prakash, "and they inflict enough damage…then even our response may not be assured…"[615] In the SFC's internal war games involving 'first-strike' scenarios, the results are grim: the war dead numbering in millions, the losses of nuclear vectors and warheads in large numbers and the debilitating impact on command and control.[616] Based on the dry runs to simulate what it would take to launch successful retaliatory strikes amidst the compressed decision-making time frames, the SFC's focus has therefore turned to building the sinews of its response mechanisms. One obvious focus is physical infrastructure, which encompasses everything from secure communication networks, multiple and redundant command and control nodes, safe storage and launch hideouts for the nuclear force, and robust transport links for the secure passage of warheads, fissile cores and delivery vehicles.[617] Away from the shadow of nuclear hardware, the latter are the invisibles that are becoming the focus of budgetary attention.

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[614] Bhavnani and Shankar, interviews with author.
[615] Ibid.
[616] Bhavnani and Shankar, interviews with author.
[617] Ibid.

Side by side with physical infrastructure growth, human capital development is the other invisible that has become the focus of attention. As mentioned earlier, SFC's staff is now nearly 100 strong and greater expansion is planned in the future. Soon after it was first instituted in 2003, "SFC postings were considered some of sort of a shit creek…a dead-end career move," according to a Shankar. This was partly the result of new tri-service cooperation rules under which officers did not know how they would stand in their parent service after a joint-services stint. But that changed mid-decade. Human resource development tasks for the SFC are now set at the prime ministerial level. Officers serving in the SFC are better paid than their counterparts in other military commands. SFC postings are also regarded upward career moves. All officers assigned to the SFC now come in at senior levels, by which time they are already through with assignments at the staff college and higher command institutional training. Once officers are deputed to the SFC, their focus becomes exclusively nuclear and they learn "on the job" doing staff work. Furthermore, once an officer joins the SFC, there is continuity even when he returns to his parent service. The officer is "recycled," meaning he returns to the SFC at a later date, at more senior levels. The two key aspects of this process are "continuity" and "recycling."[618]

All this said, infrastructure and human capital development are weak proxies for operational management. The latter is the aggregation of intra- and inter-agency cooperation practices. It is the net effect of the actualization of SOPs and cooperation rules on the ground. Within the military itself, the failure of the CDS system has greatly delimited intra-agency cooperation. To be sure, SOPs have been prepared to coordinate action between the SFC

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[618] Shankar, interview (2) with author.

and the services. The formal rules mask the enormous significance of formal command, tasking and coordinating functions. In India's case, the SOPs allow the quarantining of dual-use vectors. Nonetheless, the SFC commander cannot on his own task the service chiefs due to his junior rank. He similarly "has to borrow assets" from the latter for mission support. Since the services retain control over most nuclear vectors, training for nuclear missions and their mission support functions also devolves upon them.[619] Further, because of the SFC's compartmentalization within the tri-service IDS, the SFC's routine tasking requests to tri-service agencies are routed through the CoSC.[620] All SFC-service conflicts are also resolved at the level of the CoSC, which is a committee of equals. Gridlocks, should they occur, cannot be resolved by the chiefs. Such institutional conflicts in the nuclear realm can only be resolved at the level of the NSA in the PMO. Former staffers in the NSA's secretariat have complained about having to fight the military's intra-agency battles.[621] Such cumbersome institutional arrangements, senior Indian military leaders fear, do not bode well for intra-agency cooperation during war, especially one each service operates as an independent fiefdom and where conventional and nuclear operations are compartmentalized.

In comparison to intra-agency cooperation however, inter-agency cooperation has even greater room for tensions and gridlock. Among the three groups that control nuclear weapons – the political class, the scientific agencies and the military, the latter is at the bottom of the social hierarchy.[622] Neither the SFC commander nor the CoSC can direct the two scientific agencies, BARC and DRDO, to do their bidding.[623] Likewise, neither do the

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[619] Prakash, interview (1) with author.
[620] Shankar, interview (1) with author.
[621] Chandra, Deputy National Security Advisor (1999-2004), interview with author.
[622] Bhavnani, interview (1) with author.
[623] Prakash, Bhavnani, and Shankar, interviews with author.

scientific agencies have jurisdiction over each other.[624] Only the NSA has that authority, in

effect making him the institutional bottleneck for all aggregating decisions within

government.[625] Three problems, all of which threaten operational efficiency, have arisen

from the current management practices. The first is a classic principal-agent problem. The

principals, the political class in this case, lack the knowledge and expertise to effectively

monitor their agents, both the scientific and military agencies. In the case of the scientific

agencies, institutional means to resolve problems of weapons reliability are lacking.[626] In their

lieu, civilian leaders privilege trust and personal relationships instead of scientific peer review

processes to resolve credibility concerns. The institutional parity between the weapon

developers (scientific agencies) and their users (military) also leaves the resolution of

reliability issues in an institutional limbo. Second, the scientific agencies individually do not

exercise any crosscutting authority over one other. Neither does the military exercise control

over the procedures and training protocols developed by the scientific agencies individually.

Such compartmentalization creates gaps in operationalization: the mastery of the "man-

machine" mix. Finally, the civilians, the political class and their bureaucratic advisors, have

no "stomach for conventional or nuclear operations."[627] In the case of conventional

operations, the civilians have ceded nearly full institutional control to the military. Fearful of

nuclear operations they have sought to over-centralize control, thereby impeding planning,

training and execution.

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[624] Karnad, p. 82.

[625] Koithara, "India's Nuclear Force Management System," *Managing India's Nuclear Forces*, pp. 190-193.

[626] Chairman, Chiefs of Staff Committee, 'R', non-attributable interview (1) with author.

[627] Ibid.

It is this weak intra- and inter-agency coordination and the poor aggregation at the top, Indian military leaders claim, which is the bane of the India's recessed posture and divided command and control institutions. These institutions implicitly reflect best practices drawn from Sagan's application of Perrow's "normal accidents" theory to military-nuclear organizations. Very simplistically, the fundamental assumption of the Perrow-Sagan model is that tight coupling among highly interactive techno-organizational complexes with many moving parts constitutes the enabling condition for accidents.[628] As one thing goes wrong, it rapidly cascades through the tightly integrated system to produce catastrophic failure. India's operational model of force management, partly through agency and partly through historical path dependency conditions, aims to avoid this pitfall by adopting the logic of loosely coupled complex interacting systems. What Indian military leaders fear however is that the arsenal's loose coupling superimposed on weakly coordinated organizational links and relatively compartmentalized common operating procedures among the nuclear and military agencies will produce a logistical failure or accident. The loose coupling per se is not the problem. But the lack of a thick common institutional knowledge base and coordination and training practices to enable the military master the "machine-man" complex is.[629]

In an ideal world where operational concerns trumped all others, the military would seek to recast the existing principal-agent relationship; replacing the current scientific-bureaucratic domination of the military with control directly exercised by the political leadership. Institutionalization of the position of CDS would also proceed forward to raise the level of intra-service coordination and command. But neither is likely in the near term. However, the military has sought to make an end run around the current institutional logjam by persuading

[628] Sagan, "The Origins of Accidents," pp. 43-45.
[629] Koithara, "Operational Level Management," pp. 161-168.

the political leadership to create a professional, composite, and integrated staff to advise the government on nuclear and related strategic issues at the level of the NSA. This new body, the Strategy Program Staff, draws personnel from BARC, DRDO, and the SFC. It consists of operations research specialists, mathematicians, a nuclear net assessment specialist, and military planners advise the NSA and the PMO and help give long-term direction to India's nuclear strategy and assets/infrastructure development. More important, in light of the time compression in nuclear decision-making, the military hopes the new body will better assist the NCA to perform its executive functions.[630]

Conclusion

Following the 1998 nuclear tests and formal claims to nuclear power status, the Indian state has gradually shifted from a process of nuclear adaptation to nuclear learning. In adaptation, systems respond incrementally to systemic pressures. They develop new technological programs and add corresponding institutional and organizational routines to older ones without fundamentally questioning the means from ends initiatives. However, in learning, systems respond strategically to align means with ends. Epistemic communities and organizational decision-making structures help determine whether states simply adapt or seriously learn when confronted with systemic threats.

In the pre-1998 era, nuclear epistemic networks were weakly institutionalized within the Indian state. Members of the nuclear network were thus unable to extract commitments from their political overlords. Virtually all information concerning the nuclear weapons program in this era was tightly compartmentalized. In the absence of information availability

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[630] Shankar, interview (1) with author.

and turnover, peer review of the state's nuclear decisions was impossible. Further, due to the disaggregated nature of policy planning and decision-making within the state, serious gaps in India's operational nuclear capabilities remained unaddressed.

The absence of strong institutions and organizational processes had spillover effects in the post-1998 decade as well. Affairs continued as earlier, at least for the first half of the decade following the 1998 tests. Decision-makers continued to resort to gut checks and the resolution of problems in the sequence in which they presented themselves. Operational planning suffered as the military's role remained non-institutionalized and decision-makers attended to first-order political problems thrown up by India's formal claims to nuclear power status. Some optimization in tactical operational planning and at the procedural level has followed the institutionalization of the SFC since 2003. However, in areas such as force lethality, the path dependent effect of prior principal-agent relationships has closed off the road to any further optimization. Similarly, intra-military and inter-organizational operational management and coordination remain principal concerns.

However, starting in the latter half of the last decade, the Indian state has begun to slowly institutionalize an operationally centric epistemic community in the office of the prime minister. Consisting of scientists, technologists, policy planers and the military, this group has begun to superimpose deductive planning approaches on what was earlier an ad hoc and disaggregated policy process. With greater information availability and turnover within this group, some "truth tests" or peer review processes are now possible in both technical and organizational domains. The end of the internal regime of nuclear opacity has also created organizational space for problem decomposition and resolution by multiple agencies within

the state. These latter conditions have injected competition and oversight over what was once an insulated and black-boxed area of state policy. More significant, however, the institutional and organizational changes cumulatively hold the promise of transforming what was earlier a heuristics-based approach to nuclear policy into a more structured and rational one.

CHAPTER SIX

CONCLUSION:

In this dissertation I have developed a theoretical framework and presented evidence to show the unusual time lags in India's development of an operational nuclear capability. I have identified the institutional and organizational pathologies that are responsible for Indian's inchoate response to an emerging Pakistani threat in the 1980s, its hesitancy in embedding nuclear weapons within soft operational routines during the 1990s and the slow tempo of operational developments in the decade thereafter. Institutional and cognitive decision-making frameworks, I argue, explain these phenomena better than traditional structural, normative and cultural ones.

Specifically, I tie the Indian state's decision-making pathologies to weak learning among its leaders. I attribute weak learning in turn to poorly functioning knowledge markets within the state, informal and *ad hoc* decision-making processes and virtually non-existent institutional oversight. The causal reason for these prevailing institutional practices, I argue, was India's regime of internal opacity, which stymied institutional processes and distorted the state's oversight mechanisms. Cumulatively, secrecy cocooned Indian leaders in an environment of relative ignorance, which produced sub-optimal outcomes.

Even in the post-1998 era, the period in which India has gained acceptance as a *de facto* nuclear weapons power, doubts remain of India's ability to operationally deploy a nuclear force effectively. This has as much to do with the lock-down effects of past technical choices as the difficulties India's national security managers face in sloughing off past institutional

practices. In the last decade, especially from 2006 onward, India's nuclear trajectory has aligned more closely with the expectations of structural theories. After stepping out from behind the veil of secrecy, Indian leaders have gradually mobilized a wider range of national security actors within the state, institutionalized structured decision-making processes and established oversight mechanisms to monitor the performance of the nuclear enclave. However, the time it has taken Indian policy to match the rationality and optimality assumed in principle by structural theories points to the stickiness of existing institutions and the path dependencies they engender through sunk costs.

Among all nuclear weapon powers, India's case stands out as an exception. Although India's development timeline for building a nuclear device is equivalent to that of its peers, it took India nearly four times as long to finish the process of weaponization. India's gap between weaponization and the development of soft operational routines also compares unfavorably with other nuclear weapon powers. Due to this gap in state performance, two questions arise. First, if India is an exception then what explains that exception? Is there something specific about Indian institutions, the nature of its bureaucracy or its civil-military relations that set it apart from other nuclear weapon powers? Second, if secrecy and the institutional-organizational pathologies associated with it produces distortionary effects, then are similar effects observable in other cases of nuclear proliferation? If they are not, then the natural question is why not? After all, secrecy is an institutional characteristic of all nuclear weapon programs. Is there then some variation in the institution of secrecy that distorts rationality and produces sub-optimal outcomes?

So far as bureaucracy is concerned, the Indian nuclear weapons program operated within a sequestered enclave. The state did not establish its standard supervisory controls over it and compensated for that deliberate oversight by placing the enclave under the direct control of the PMO. However, the development history of other nuclear weapon powers suggests that India's practice was not unusual. In the US, the Manhattan Project unfolded under the direct oversight of the president and a small council of senior advisors. Through the duration of World War II, Congress, the president's cabinet and other oversight authorities within the US government knew nothing of it. In France, scientists enjoyed significant autonomy in the first seven years of the nuclear program and civilian bureaucrats deferred to their judgments. In Israel as well, Prime Minister Ben Gurion ran the Dimona nuclear reactor project as a state within a state. The examples of China, Pakistan and Iraq were no different. In all states, nuclear enclaves showed characteristics of high centralization and administrative autonomy. The difference between the Indian and the US, French, Israeli and Pakistani cases, however, lies in the treatment accorded to institutional processes and the near total absence versus the existence of some albeit weak oversight mechanisms.

The second question concerns civil-military relations. Many attribute the distrust in India's civil-military relations as the cause behind its odd nuclear behavior. If this were true, however, we would see manifestations of distrust elsewhere: in conventional war operations and in military aid to civilian authorities. However, we observe contrary trends in both cases. The Indian military enjoys near total autonomy in conventional war operations. Civilians set strategic goals and allow the military autonomy to plan and execute operations.[631] India's civilian leadership has also not hesitated to use the military to manage India's internal crisis

[631] Srinath Raghavan, "Soldiers, Statesmen and India's Security Policy," *India Review,* Vol. 11, Issue 2, (May, 2012), pp. 116-133.

of governability. As Shashank Joshi has pointed out, of the 17 major military campaigns the Indian military has conducted in post-independent India's history, 12 were domestic in nature. Between 1982-1989 for example, the army deployed 721 times to assist civilian authorities.[632] Over the last decade as well, the Indian military's role has become institutionalized in the nuclear decision-making process. In fact, over the last decade, the SFC has gained significant influence in nuclear force planning, user certification of weapon systems and the development of command and control institutions, training, and infrastructure invisibles. Institutional and operational changes in Indian nuclear planning have come without any fundamental rewrite in the DNA of civil-military relations

In other nuclear weapon powers as well, governments gradually shared control of nuclear weapons with the military. Decision-makers either kept nuclear weapon programs outside the purview of the military as an institution or compartmentalized them within a small section of the services. A prominent example of this policy behavior is the US itself. Although the US allocated nuclear bombs to the air force for use against Japan during World War II, the Joint Chiefs and the air force were not privy to details about the nuclear weapons until 1949, the year the Soviet Union ended US nuclear monopoly and forced President Truman's administration to take nuclear operational planning seriously.[633] In France too, with the exception of a small group of military officers, the military as an institution remained more interested in guerilla warfare in the colonies and conventional rearmament,

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[632] Shashank Joshi, "The Indian Mutiny That Wasn't," *Foreign Policy,* (April 5, 2012), http://www.foreignpolicy.com/articles/2012/04/05/the_indian_mutiny_that_wasn_t?page=full, (May, 2012).
[633] Greg Herken, "Diplomacy and Deterrence: The Military Dimension," *The Winning Weapon: The Atomic Bomb in the Cold War*, (New York: Knopf, 1980), pp. 195-337.

until the Gaillard government signed off on the development of a nuclear device in 1958.[634]

In the Israeli case, the 1967 Six-Day War catalyzed the military's institutional participation in

nuclear operations planning.[635] The Pakistani program too began as a civilian enterprise. The

Pakistani military gained control of the program in the aftermath of a coup in 1977. But until

the early 2000s, institutional planning with regard to nuclear weapons was tightly restricted

to a small section within the military.[636]

The difference between India and most other nuclear weapon powers essentially centers on

the process of weapon development and operational plans and procedures concerning it. In

other nuclear powers, the decision to develop nuclear weapons was followed by the

mobilization of a highly select but diverse set of epistemic actors. The latter included

scientists, civilian bureaucrats, military leaders and political authorities. The epistemic actors

enjoyed formal institutional status and had relatively easy access to decision-makers. Once

institutionalized, the epistemic actors were successful in persuading decision-makers to make

political and budgetary commitments to bring the programs to fruition. No doubt, decision-

makers reduced the scale and scope of structured decision-making. But they did not abandon

structure altogether. Above all, despite the regime of secrecy, the principals ensured a

modicum of agent competition and third-party scrutiny to monitor the performance of the

programs.

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[634] Lawrence Scheinman, "The Basis of the French Bomb," *Atomic Energy Policy in France Under the Fourth Republic,* (Princeton: Princeton University Press, 1965), p. 126.
[635] Avner Cohen, "Toward Opacity," *Israel and the Bomb,* (New York: Columbia University Press, 1998), pp. 278-279.
[636] Khan, "Toward an Operational Deterrent," *Eating Grass,* 287-355.

The institutional difference between the United States, France, Israel and Pakistan and India is one between the degrees of secrecy. Secrecy can be conceptualized as a continuum - low, medium and high - along two axes: internal and external. High external secrecy has a less debilitating impact on the domestic management of the program than a corresponding regime of high internal secrecy. The two are no doubt interlinked. A state most concerned with hiding its proliferation effort from external scrutiny will also be inclined to keep it under tight wraps domestically. Correspondingly, a state less concerned with external secrecy will have more breathing room for establishing institutionalized management controls within. A lower degree of domestic secrecy also creates more institutional space for structured decision-making and parallel problem solving across multiple agencies within the state.

In the rest of the chapter I briefly survey the nuclear management practices of four states to compare and contrast them with India's. I classify India as a case of high external and domestic secrecy. My first three comparison cases are France, Israel and Pakistan. I show that France falls in the category of low external and medium domestic secrecy; Israel of medium external and medium domestic secrecy; and Pakistan of low external and medium domestic secrecy. I argue that the absence of high external and domestic secrecy in France, Israel and Pakistan were permissive conditions that allowed decision-makers and planners to design better institutional means to manage nuclear weapon programs. My fourth case is Iraq, which I show closely parallels India because it too followed institutional practices of high external and domestic secrecy. The Iraqi example, I argue, reveals many of the institutional pathologies that stymied Indian management. Other examples of states, which instituted regimes of high external and internal opacity are Libya and Iran. The latter two are

promising avenues for future research but are not part of this chapter. I finally cap the chapter with a brief hypothetical discussion of the sources of India's exceptional regime of secrecy.

Regimes of Moderate Secrecy and Proliferation Outcomes

The French, Israeli and Pakistani cases are time-lapse mechanisms that capture institutional variations in the regime of secrecy. Although each state conducted its nuclear program in secrecy, the secrecy was never sufficiently acute to jeopardize institutional controls within the state.

France

In many ways the French route to nuclear weapons shares similarities with India. As in the Indian case, strong political direction was lacking. The political characteristic that best defined the French Fourth Republic was a series of unstable governments and rapidly changing cabinets. Prime ministerial direction was sometimes contrary to actual policy suggesting that prime ministerial incumbents were not on top of their nuclear policy game. Just like in India, a relatively small group of people in positions of authority operating though informal channels worked on the atomic energy program.[637] And yet unlike India, despite the political drift, the French nuclear weapons program proved remarkably successful. Beginning in the mid-1950s, it took France just five years to explode a nuclear

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[637] Scheinman, "Introduction," *Atomic Energy Policy in France Under the Fourth Republic,* pp. xvi-xviii.

device.[638] Equally significant, weaponization and deployment followed in the immediate aftermath.[639]

On closer examination, the evidence suggests that similarities between the French and Indian cases are more apparent than real. For one, the secrecy in the French program was not so obsessive so as to prevent the mobilization of epistemic actors or coordination across multiple agencies. Prior to World War II, France was one of the leading centers of atomic research in the world. Subsequent to World War II, the French government sought to resume the interrupted research for both civilian and potentially military purposes.[640] There was little reason for excessive secrecy because there was no major opposition to the French program. The US knew little of the French program in its early stages from 1947-55. Further, until Eisenhower's 'Atoms for Peace' program in 1953, the US was ambivalent about proliferation in the international system.[641] Indeed, the French were so open about nuclear weapons development and impending tests in Algeria in the late 1950s that Morocco along with some other African states introduced a General Assembly resolution in the UN concerning the anticipated fallout from those tests.[642]

The difference between the French approach to nuclearization and the one adopted by the US and Britain was the lack of sustained top-down political direction. The lack of such

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[638] Wilfrid L. Kohl, "Background," *French Nuclear Diplomacy,* (Princeton: Princeton University Press, 1971), pp. 19-20.

[639] Kohl, "The Gaullist Force de Frappe," *French Nuclear Diplomacy,* pp. 100-106.

[640] Scheinman, "Background and Structure of the CEA," *Atomic Energy Policy in France Under the Fourth Republic,* pp. 3-9.

[641] Maria Zaitseva, "Nascent Stage," *When Allies Go Nuclear: The Changing Nature of the American Response to 'Friendly' Nuclear Programs,* PhD Dissertation, Cornell University, 2011, p. 44.

[642] Zaitseva, "Intermediary Stage," *When Allies Go Nuclear,* p. 102.

political direction however did not mean that administrative direction was lacking as well. The French civilian bureaucracy wielded great power in drafting the directing and execution of the nuclear program. The lack of political direction and the absence of external opposition allowed policy entrepreneurs inside the bureaucracy free reign to shape policy. Three characteristics contributed to the successful execution of the French program. The first was the mobilization of an array of epistemic actors beyond scientists. Second, the French bureaucrats formalized the policy planning process. All policy was subject to scrutiny by independent committees of scientists, private industry and civil bureaucrats before formal approval by political leaders. Third, strong institutional controls mitigated principal-agent problems common to all sequestered decision-making environments.

The scientists under the leadership of Joilot-Curie dominated the program only briefly in its inception phase from 1945-52. The goals of the bureaucrats and scientists in this phase were to bring the French program back up to speed from where it had left off in the pre-World War II era, signal French interest in atomic energy and become included in the US-British strategic partnership. The primary focus of the *Commisariat a l'Energie Atomique* (CEA) in the first seven years was therefore research and competence building.[643] Thereafter, the CEA's goal became industrial. It shifted to the production of electricity from atomic energy and possibly build nuclear weapons. With this change, power also shifted away from the scientists in favor of civilian administrators.[644]

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[643] Scheinman, "Background and Structure of the CEA," pp. 7-8.
[644] Scheinman, "The First Five Year Plan: Option for the Future," *Atomic Energy Policy in France Under the Fourth Republic*, pp. 58-62.

The end of the autistic phase of the research and development program and the linkage with

tangible industrial objectives invariably led to a wider mobilization of epistemic actors.

Scientists came under pressure to accept the judgment of "technicians" and "planners."[645]

The need for specialized material and equipment for the conduct of nuclear experiments led

to the establishment of linkages with French private industry. In the post-1952 phase, the

Industrial Equipment Committee advised the CEA on all industrial, equipment and plant

matters. The entire membership of the committee, 6-12 members, was associated with

private industry.[646] In the absence of any overwhelming requirement for secrecy, the military

had representation in the CEA. There was no pressure from senior military leaders to build

nuclear weapons. But the plutonium production program did not go unnoticed within the

military. As the plutonium production plan gained momentum within CEA, the

Commandement des Armes Speciales conducted studies to include the use of nuclear weapons and

conditions necessary for their manufacture. The study concluded that nuclear armament was

conceivable for France.[647]

Institutional controls were weak in only the first seven years of the CEA's inception. During

these years, the CEA was unique among other French public sector organizations, which

included electricity, gas, coal and banking. A ministry typically exercised control over a

public sector organization. In contrast, the CEA was granted administrative autonomy,

placed under the control of the prime minister and removed from the control of the

traditional bureaucracy.[648] The CEA was a "bicephalous" organization with a scientist High

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[645] Ibid., p. 63.

[646] Scheinman, "The Basis of the French Bomb," *Atomic Energy Policy in France Under the Fourth Republic,* p. 102.

[647] Ibid., pp. 100-101.

[648] Scheinman, "Background and Structure of the CEA," pp. 9-12.

Commissioner (HC) and a bureaucrat Administrative-General (AG) at its head. Both were co-equal and in case of a dispute the prime minister arbitrated matters.[649] In the first seven years the scientific experts gained almost exclusive control of the CEA due to the absence of parliamentary and cabinet guidance. Frequent changes in the cabinet made links with the government tenuous. Due to this lack of political interference, the CEA became used to "freedom of action" and "autonomy." Joilot-Curie's towering personality and the solidarity of the scientists also compelled the administrative branch of the government to defer to the scientific leadership.[650] But even during the CEA's phase of relative autonomy, the civilian administration exercised institutional checks on the CEA through an independent Scientific Council, which consisted of 10 scientists who were external to the commissariat and among the most prominent scientists in France.[651]

After the CEA's industrial turn of direction in 1951-52, institutional controls and oversight authority over it were strengthened. As early as 1950, the HC and *eminence grise* of French nuclear science, Joilot-Curie, was forced to resign his position because of his communist leanings.[652] During the first phase of the nuclear program, a Secretary General (SG) served as the link between the HC and the AG. In 1953, the post of the SG was abolished because it represented a threat to the office of the AG.[653] The selection of associates on the governing body of the CEA and the issues brought before the inter-ministerial body in government also became the AG's prerogative. The number of associates appointed to the CEA's governing board was increased. The new board included scientists to assist the HC,

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[649] Ibid., pp. 14-15.
[650] Ibid., pp. 17-18.
[651] Scheinman, "The Formative Years: 1946-51," *Atomic Energy Policy in France Under the Fourth Republic,* pp. 31-32.
[652] Ibid., pp. 36-48.
[653] Ibid., pp. 50-51.

members of industry, a military representative, the director of the *Centre National de la Recherche Scientifique*, and three civil servants appointed by the prime minister. This gave the civilian bureaucrats dominant control over the CEA.[654] The independent Scientific Council was also expanded from 10 to 15 members. It was given more formal powers including the power to render advice independent of the CEA on all matters submitted to it. Furthermore, the AG acquired the power to revoke contracts without approval of the HC in matters of scientific and technical personnel.[655] Such institutional controls and oversight authority mitigated some of the classic principal-agent problems that afflict closed decision-making systems.

Without doubt, the French nuclear weapons program was fragmented. Many scientists in the CEA were opposed to building weapons on moral grounds. They were also concerned that a military program would precede the peaceful uses of atomic energy such as the building of electricity generation reactors; the bomb would siphon off money from such projects.[656] The French military as an institution was generally more interested in the insurgent war in Indo-China and in building up its conventional military strength.[657] But despite the absence of overwhelming support for nuclear weapons, as an institution, the military undertook routine steps to acquaint military officers with atomic weapons and energy. Initial studies conducted by the military involved protection from atomic weapons rather than use. The Army also started the practice of sending a small group of officers to the CEA and universities annually for training in the nuclear sciences.[658]

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[654] Ibid., p. 52.
[655] Ibid.
[656] Scheinman, "The Basis of the French Bomb," pp. 109-111.
[657] Ibid., p. 99.
[658] Ibid.

Pressure for the weapons program came from civilian administrators such as Dautry and Lescop who gave it continuity. They, together with a small number of allies in the cabinet and the military, they gave it strong central direction. As the nuclear weapons program gained momentum in the mid-1950s, the civilian bureaucrats built a coalition with the services and persuaded the army to invest in a plutonium production reactor and the navy to invest in reactor project for nuclear submarines.[659] The involvement of the services in the nuclear project through representation in the CEA, through investments in the CEA's various projects and through training routines were standard coordination practices in an institutional setting where the nuclear weapons program was a classified project but not one that was subject to external threats, denial or excessive domestic secrecy. Despite the overall fragmentation and lack of political direction, there was an administrative continuity and simultaneity that gave the project technical coherence once political leaders decided in favor of a nuclear weapons program.

Israel

Unlike France, Israel developed its nuclear weapons program under a regime of medium external and domestic secrecy secrecy. A higher degree of external secrecy was considered necessary to protect France, Israel's key supplier of the Dimona reactor and plutonium reprocessing plant. It was also a means to deny hostile Arab states the opportunity for pre-emptive attacks on Dimona and to stave off pressure from the United States. The Israeli program spawned the regime of what we now term "nuclear opacity" under which a state

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[659] Ibid., pp. 122-123.

hints that it possesses nuclear weapons but then denies having them. All this said, however, there was no excruciating international pressure on Israel, either economic or military, to terminate its nuclear weapons program. The United States was ambivalent.[660] After Egypt's military setback in the 1955-56 Suez Crisis, the threat of a pre-emptive strike on the Israel's Dimona plutonium production plant became manageable. In the aftermath of the Suez crisis, the French became even more steadfastly committed to investing in Israel's nuclear weapons effort. And the British defended Israel's nuclear innocence in public.[661]

As with any secret program, institutional controls were weak. The Israeli parliament, the Knesset did not know of it until the project was well underway. The full cabinet did not debate its merits and implications. The program operated under the direct control of Prime Minister Ben Gurion and his principal aides in the defense ministry, Peres and Bergmann. Within the defense ministry itself, the program was fragmented. There was no formal chain of command or standardized procedures and accountability mechanisms. Defense minister Peres who ran the project on the prime minister's behalf believed in personal relationships. The unusual nature of fund raising for the project through private donations also injected an element of non-accountability.[662]

But the evidence is more complex. Although the nuclear weapons project was not debated within the cabinet at large, leading cabinet ministers and leaders of the ruling MAPAI party leaders knew of it and contested key aspects of the project. The Dimona project was also monitored by a section of nuclear scientists located in the Weizmann Institute outside the

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[660] Zaitseva, "Nascent Stage," pp. 60-61.
[661] Ibid., p. 70.
[662] Cohen, "The Road to Dimona," *Israel and the Bomb,* pp. 69-70.

state. This group of nuclear scientists acted as an independent institutional check. Third, as the Dimona reactor neared completion in 1963, Prime Minister Eshkol who succeeded Ben Gurion, ended the bureaucratic fragmentation and established centralized control along with accountability mechanisms. Finally, the lack of significant international opposition to the program and French role as a supplier of critical technologies, plant and equipment, mitigated internal principal-agent problems and allowed Israel to pursue weapon development and delivery simultaneously.

Between 1955 and the end of the 1960s, Israel was extraordinarily sensitive to the French need for secrecy. Due to the unprecedented nature of the Dimona deal, French politicians were unsure if France should go through with it entirely. For that reason, there were two parts to the Dimona agreement. The first part was political in which French commitments to Israel were left deliberately vague. The second half was the technical agreement that too did not mention sensitive details about the Dimona project such as the size of the nuclear reactor and most importantly, details of the spent-fuel reprocessing plant, the key to producing weapons-grade plutonium. Both governments circumvented details by dealing with French companies directly.[663]

Within Israel itself, the Dimona project, was not debated in the full cabinet. However, key ministers in Ben Gurion's government such as Peres (defense), Eshkol (commerce), and Meir (foreign affairs) – knew of it, if not all the details. Meir in particular contested the project and that conflict became intertwined with her political rivalry with Peres. As foreign minister, Meir resented Peres's direct dealing with France, which she argued circumvented

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[663] Cohen, "The Road to Dimona," pp. 58-60, 73-75.

the foreign affairs ministry and amounted to a separate foreign policy.[664] Separately, the

ruling MAPAI party's senior leadership resented the secrecy of the project and Ben Gurion

and Peres's creation of a state within a state.[665]

The Dimona project was also monitored externally by a strong lobby of nuclear scientists

housed in Weizmann Institute, which was home to nuclear physicists focused on pure

research other than the Israel Atomic Energy Commission (IAEC), the state agency

concerned with industrial projects. Within the state, Dimona was spearheaded by Bergmann

who had a falling out at the Weizmann Institute over its institutional direction in 1951 after

which he left and began his appointment as scientific advisor to Prime Minister Ben

Gurion.[666] Bergman found an ally in Mardor in the defense ministry. A team of nuclear

physicists led by Shalit and Ze'ev opposed Dimona for both its scale and audacity. More

specifically, they questioned Bergmann and Mardor's competence to execute so complex and

immense a project. In response then Defense Minister Peres formed a special three-man

committee comprising Shalit, Ze'ev, and Lipkin to plan and monitor the project

independently. Further, Bergman and Mardor were removed from direct oversight of the

project. Peres also brought in a Colonel Manes Pratt, military officer from the outside, to

execute the construction of the Dimona reactor and plutonium separation plant.[667]

In 1963 Eshkol succeeded Ben Gurion as prime minister. As the Dimona reactor neared

completion, Eshkol's government enacted a series of organizational, financial, technical and

strategic reforms within the defense ministry and the atomic energy sector to institutionalize

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[664] Ibid., pp. 71-72.
[665] Cohen, "Debate at Home," *Israel and the Bomb,* p. 140.
[666] Cohen, "Before the Beginning," *Israel and the Bomb,* pp. 27-31.
[667] Cohen, "The Road to Dimona," p. 67.

nuclear weapons production and embed it within institutional oversight, organizational

coordination and a web of strategic thought.[668] During Ben Gurion's time, Peres ran the

Dimona project out of defense ministry. He sub-divided the project into a series of mini-

projects and managed them on the basis of personal relationships with individuals who ran

them. But there existed no centralized institutional management beyond Peres. Eshkol and

his band of reformers changed all that.

As a first step, Eshkol installed the economist and his senior aide Dinstein as Deputy

Minister of Defense. As Dinstein recalls, until his time, there was no clear hierarchy, no clear

chain of command, no clear cut division of labor, and no established procedures for order of

business in the Dimona project. This is consistent with the theoretical observation in this

dissertation that secrecy induces disaggregation and non-institutionalization within

organizations. However, Dinstein ended the fragmentation within the nuclear program and

established central oversight. Between 1955-1965, for example, the scientists had assumed

oversight role in the program due to the absence of an independent authority. Dinstein

brought an end to this practice by strengthening the role of the scientific advisor to the

defense minister and institutionalizing his power with an independent advisory body.

Similarly in 1965, Dinstein also divested control of the "leading project" from RAFAEL, the

defense ministry's scientific research and development body, and shared that authority with a

revived IAEC.[669]

The Dimona complex yielded plutonium in 1965. By 1966, Israel had accumulated sufficient

plutonium to build a bomb. In November 1966 Israel conducted a critical test, most likely a

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[668] Cohen, "Growing Pains," *Israel and the Bomb,* pp. 223-228.
[669] Ibid., 228-231.

'cold test' to validate the weapon's design.[670] Parallel with the bomb program, Israel contracted to purchase nuclear-capable combat aircraft and ballistic missiles from France in 1963.[671] The special technical partnership with France and the absence of disruptive US pressure made that feasible. Simultaneously, Eshkol roped in the military to think through how Israel might plan to use nuclear weapons. The composite group consisted of Eshkol, Dinstein, Rabin, Yuval Ne'eman, and Colonels Avraham, Tamir, and Freier. Around 1966, Israel also commenced long-term systematic strategic planning and introduced five-year plans for developing a force structure alongside a 10-year research and development plan.[672] The 1967 Six-Day War ultimately acted as a catalyst to further the military's participation and institutionalize its role in operational planning.

What all this evidence tells us is that despite the intense secrecy, Ben Gurion's government did not jeopardize institutional processes entirely. Ben Gurion's senior colleagues in the cabinet were aware of and debated Israel's Dimona project. Like any other classified program, Israeli leaders implemented the nuclear weapons program sequentially. Military leaders were not involved in strategic planning until the completion of the first phase of weapon development. However, many of Israel's problems with disaggregation and sequential planning were mitigated by France's role in the supply of dual-use delivery systems, both aircraft and ballistic missiles. The US decision not to challenge that supply relationship helped prevent schedule slippages. Likewise, the US decision not to disrupt Israel's nuclear quest by threatening conventional military supplies gave Israeli leaders the

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[670] Ibid., pp.231-232.
[671] Ibid.
[672] Ibid., 235-239.

structural space to partially institutionalize and coordinate the program domestically despite the high secrecy.

Pakistan

Contrary to popular perceptions, Pakistan in the early 1970s was relatively open about its interest in nuclear weapons. The event that launched the Pakistani program was a conference of nuclear scientists that Prime Minister Zulfikar Ali Bhutto called in 1972 to solicit their effort in building a bomb. The conference in the city of Multan was a relatively open one with nearly 400 attendees including westerners and journalists. At the conference, the scientists openly supported the bomb project and Bhutto promised them the resources and political support to do so. Unlike the Indian program where the decision to build a nuclear device in 1972 was reached by the prime minister after consulting three nuclear scientists privately, Bhutto's Multan meeting, according to one observer, had the ambience of a "fish market!"[673]

Pakistan's relative confidence that its bomb project would not stand thwarted had to do with its strategy and the nature of its relationship with the United States. Unlike India, which diverted fissile material from facilities acquired explicitly for peaceful purposes, Pakistan proposed to import an entire plutonium-based nuclear fuel-cycle, place all the imported plant and equipment under international safeguards, but then use the skills and experience gained from running them to replicate domestic capabilities for a weapons program.[674] To provide the semblance of a peaceful nuclear program, the Pakistan Atomic Energy

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[673] Khan, "Never Again," *Eating Grass*, pp. 86-87.
[674] Khan, "Route to Nuclear Ambition," and "Punishing Pakistan," *Eating Grass*, pp. 95-134.

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Commission (PAEC) drew up an ambitious plan to build 24 nuclear power reactors and justified its proposed heavy water and plutonium reprocessing plants.[675] Second, Pakistan's alliance and special relationship with the US also gave it confidence that Washington would likely acquiesce to a Pakistani nuclear program. Prior in 1969, Pakistan had facilitated Kissinger and Nixon's "opening" to China. Nixon returned that favor by ordering the famous "tilt" in favor of Pakistan during the 1971 Bangladesh War with India.[676]

Due to relatively moderate regime of secrecy Pakistani leaders mobilized a larger array of epistemic actors and took several steps to establish institutional controls. The latter were not entirely successful as the example of A.Q. Khan's nuclear shenanigans would later show. However, the institutionalization was sufficient for the task of coordination across multiple state agencies. In one manner, Pakistan's institutional arrangements were similar to India. The PAEC and its chairman reported directly to the prime minister / president. However, Bhutto realized that he was unable to devote sufficient time on all matters nuclear. He therefore institutionalized the process by setting up the Defense Committee of the Cabinet (DCC) as the inter-ministerial coordination arm for the weapon program within government. The DCC consisted of the ministers of foreign affairs, defense, finance, information, the three service chiefs, a representative of the PAEC and the secretary to the Pakistan Peoples Party.[677] It decided that Pakistan should pursue the nuclear cycle and the weapon design project simultaneously. Pakistan prepared a test site for the forthcoming nuclear bomb as

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[675] Ibid., p. 131.
[676] Khan, "Punishing Pakistan," pp. 135-138.
[677] Khan, "The Route to Nuclear Ambition," pp. 99,121-123.

early as 1979.[678] Further, the weapon design and test of the non-fissile material trigger assembly preceded the availability of fissile material from indigenous Pakistani facilities.[679]

It would be a stretch to argue that Pakistan pursued the development of the weapon and delivery capability simultaneously. The modification of aircraft for nuclear delivery followed the development of the weapon. However, due to the integral nature of decision-making through the DCC and the military's institutional representation on that committee, the Pakistani Air Force (PAF) was able to coordinate its efforts with the PAEC and begin tackling the task of modifying F-16s by the late 1980s. That effort did not bear fruit until the mid-1990s.[680] Until then, transport aircraft were Pakistan's delivery weapon of choice. But the PAF drew up contingency plans involving a nuclear demonstration shot using C-130 Hercules transport aircraft as early as 1986.[681] Further, Pakistan's feigned movement of nuclear assets during the 1990 Kashmir Crisis with India to draw US attention is indirect evidence of the existence of planning procedures for nuclear deployment and use.[682]

Knowledge and material assistance from China also helped Pakistan outsource many of the coordination and parallel tasking challenges that states find difficult to tackle under a regime of secrecy. The Chinese assistance involved the training of Pakistani nuclear scientists in weapon design in Chinese laboratories, the sharing of an actual weapon blueprint, the design of explosive lenses for an implosion-type weapon, the transfer of a neutron initiator, assistance with underground testing, and possibly the conduct of an actual underground

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[678] Khan, "Building the Bomb," *Eating Grass,* p. 183.
[679] Ibid., pp. 174-181.
[680] Ibid., pp. 185-186.
[681] Khan, "Military Crises and Nuclear Signaling," pp. 220-223.
[682] Ibid., pp. 229-232.

nuclear test for Pakistan at China's Lop Nur test site in 1990.[683] China also transferred

complete ballistic missile systems, the M-9 and M-11, to Pakistan in the early 1990s. The

transfer package involved training Pakistani missile operators, maintenance, and storage and

upkeep functions. China also built a turnkey missile facility in Pakistan for the manufacture

of solid-fuel ballistic missiles,[684] a step that enabled Pakistan to outsource the development

of an entire category of delivery vehicles to a legally recognized nuclear weapon state, which

was relatively immune to nonproliferation pressures.

Like other organizations where information flow is generally restricted, the Pakistani state

and decision-makers also encountered difficulties in monitoring the performance of their

scientific agents. Thus, despite Bhutto's enthusiasm for the plutonium fuel cycle between

1972-76, he was unable to accurately assess the claims of the PAEC that it was making

progress. One method leaders use to monitor performance within organizations is agent

competition. The latter lowers the cost of information exchange and shines the light on

problems, successes and failures. Regimes of secrecy however raise the bar for information

exchange thereby compounding the problem of management. Pakistani leaders did not

design agent competition but stumbled upon it by pursuing the plutonium and uranium

routes to nuclear weapons simultaneously. The agent competition became institutionalized in

the PAEC under Munir Ahmed Khan, the organization tasked with mastering the plutonium

fuel cycle and the Engineering Research Labs (ERL),[685] the organization that under A. Q.

Khan led Pakistan's centrifuge-based uranium enrichment program. Both entities and their

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[683] Reed and Stillman, "The Fakirs: India, Pakistan and North Korea," pp. 252-253.
[684] Khan, "Pakistan's Missile Quest," pp. 238-242.
[685] President Zia renamed ERL as Khan Research Laboratories in honor of Dr. A.Q. Khan.

leaders acted as conduits of information for political decision-makers.[686] They also provided institutional oversight over each other. Zia who succeeded Bhutto after staging a coup realized the benefits of this competition and extended it to nuclear weapon design.[687] Likewise, in the 1990s, the PAEC and the ERL competed against each other in the development of ballistic missiles, with the former pursuing solid-fuel rockets through collaboration with China and the latter liquid-fuel systems in collaboration with North Korea and Iran.[688]

The agent competition did not address the problem of information asymmetries entirely. Pakistan's dictator General Zia discovered to his unpleasant surprise that A Q Khan was prone to manipulating his political masters. Zia subsequently divested control of the weapon development project from ERL and reverted it back to the PAEC's control.[689] Subsequently in the 1990s, Khan peddled centrifuge and nuclear weapon designs to other states including Iran, Iraq and Libya among others. The Pakistani government denied sanctioning these deals and cited the problem of information asymmetries and control in conditions of secrecy.[690] The agent competition between PAEC and ERL also produced distrust and inefficiencies in the Pakistani program.[691] The PAEC, for example, favored indigenous technologies versus Khan who preferred foreign vendors and refused critical inputs from domestic Pakistani vendors for his uranium enrichment plant. In the larger scheme of things, however, the agent competition between the PAEC and ERL worked to Pakistani decision-makers'

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[686] Khan, "Mastery of Uranium Enrichment," and "Mastery of Plutonium Production," *Eating Grass,* pp. 147-150, 196-204.
[687] Khan, "Building the Bomb," pp. 187-190.
[688] Khan, "Pakistan's Missile Quest," pp. 238-246.
[689] Khan, "Building the Bomb," pp. 189-190.
[690] Khan, "The Unraveling of the Khan Network," *Eating Grass,* pp. 359-376.
[691] Khan, "Mastery of Uranium Enrichment," pp. 151-152.

advantage. They ultimately benefited from the independent oversight of Chinese entities and scientists who played the role of external consultants in helping Pakistan develop its nuclear arsenal.

An Example of a Regime of High-Secrecy

In comparison to the above cases, Saddam Hussein's regime in Iraq instituted a regime of high external and domestic secrecy to hide its nuclear weapons effort during the 1980s. Like India, the regime of extreme secrecy became the source of several managerial pathologies, which produced serious lags in the execution of the program.

Iraq

In the aftermath of the first Persian Gulf War, it became a common assumption that Iraq was on the verge of acquiring nuclear weapons; and that had the war not intervened, Saddam would have acquired them. In the wake of the war, IAEA inspections revealed an extensive Iraqi uranium enrichment program, which encompassed all three industrial methods used to enrich uranium: Electromagnetic Isotope Separation (EMIS), gas diffusion and the centrifuge. International inspectors also discovered that Iraqi scientists were working on the design of a nuclear weapon.[692] Together with Iraq's possession of biological weapons and toxic nerve agents such as VX, Iraq emerged as the new menace in the Middle East. The discoveries concerning the scale and scope of Iraq's nuclear ambitions came as a shock because so little was previously known about them in the outside world; and also because of the prevailing belief that Israel had ended Iraqi nuclear ambitions in June 1981 by destroying the Osiraq reactor.

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[692] Hymans, "Spinning in Place: Iraq's Fruitless Quest for Nuclear Weapons," *Achieving Nuclear Ambitions*, pp. 84-91.

But since the early 1990s, more sober re-assessments by international inspectors and the accounts of leading Iraqi scientists in the program suggest that initial assumptions about Iraqi nuclear advances were wrong. Not only was Iraq far from producing an actual weapon immediately prior to the 1990-91 Persian Gulf War, but it is unclear if it would have succeeded in the decade after. US inspector Robert Kelley who was part of the international inspectors' team observed later that Iraq's EMIS isotope separation effort amounted to investments in an industrial project on a gigantic scale, which had little to show for it. The EMIS machines were so poorly designed that each required its own team of operators. Overall 96 machines were required for producing sufficient uranium for a nuclear weapons program. Iraq, overall, did not even possess a fraction of the technical manpower needed. The gas centrifuge project was still in the feasibility stage. Finally, the nuclear weapon design itself, according to Kelley, was more like a student project. The Iraqi scientists and engineers had ploughed through the literature and collated everything needed to build a weapon without knowing how to build a workable design.[693]

Serious management problems, according to Kelley, stymied the Iraqi nuclear weapons effort. Those problems, as the evidence below shows, had substantially to do with extreme secrecy: vertical compartmentalization of information, weak institutions, sequential planning, information asymmetries between principals and agents, and the lack of agent competition in general. Israel's destruction of the Osiraq reactor drove the program underground.[694] Prior to this event, the program had relatively strong institutional controls within and enjoyed the

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[693] Robert E. Kelley, "The Iraqi and South African Nuclear Weapon Programs: The Importance of Management," *Security Dialogue,* Vol. 27(1) (March 1996), pp. 27-38.
[694] Mahdi Obeidi and Kurt Pitzer, "The Centrifuge," *The Bomb in My Garden: The Secrets of Saddam's Nuclear Mastermind,* (Hoboken: John Wiley & Sons, Inc., 2004), p. 53.

benefit of independent French oversight, the external contracting party for the reactor. It had not been Saddam's intent to build a bomb using the Osiraq reactor. Several technical features of the reactor including its size, the nature of the special "caramel" fuel supplied by France and close monitoring by French technicians and international inspectors, rendered that impossible.[695] Iraq's goal in acquiring nuclear weapons through the reactor was likely a long-term one: to use the reactor to train scientific manpower, which could later be re-deployed to develop such weapons.[696]

But in the wake of the reactor's destruction, Saddam ordered Iraqi scientists to develop nuclear weapons. Starting in 1982, the Iraq Atomic Energy Commission's (IAEC) budget saw massive increases. Saddam ended his regime's political vendetta against several nuclear scientists and rehabilitated them. Between 1982 and 1987, the IAEC enjoyed professional autonomy and there was seldom interference by political authorities.[697] Saddam's decision nonetheless came with the very specific condition that the uranium enrichment program should not arouse suspicion abroad. The IAEC was not to procure sensitive plant, equipment or material from abroad. The entire Iraqi program therefore went underground. This had four deleterious consequences. First, Iraqi scientists settled on vintage technologies that they could develop indigenously, but also those that were unlikely to succeed in producing enriched uranium on an industrial-scale. Second, secrecy conditions forced them to proceed with each technology through the trial-and-error method sequentially, a process that produced lags in the program. Third, because of minimal contact with the outside world and reduced communications within the nuclear scientific and engineering establishment

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[695] Imad Khadduri, "Nuclear Reactor," *Iraq's Nuclear Mirage: Memoirs and Delusions*, (Toronto: Springhead Publishers, 2003), p. 74.
[696] Khadduri, "Nuclear Bomb," *Iraq's Nuclear Mirage*, p. 82.
[697] Hymans, "Spinning in Place," pp. 98-99.

itself, the programs suffered from the lack of independent oversight and scrutiny. Finally, because the scientific teams working on different uranium enrichment technologies were isolated from each other, agent competition was minimal. The result was that Saddam until very late in the game accepted the assurances of progress from his agents without the benefit of independent audits.

Iraq initially embarked on two rival paths to uranium enrichment: the EMIS and the Gas Diffusion methods. For secrecy reasons both teams worked independently of each other.[698] The head of the nuclear program Jafar Dhia drew up stringent procedures for documenting and auditing scientific and technical reports not just to assure technical quality but also to control their distribution within the agencies working on the programs.[699] To further prevent leaks, Dhia settled on an over-centralized method of management. No horizontal communication was permitted between the physics, chemistry, and engineering teams working on the projects. Each team communicated its requirements through Jafar who then passed on the design specs for equipment, plant and machinery to specific individuals and agencies. The result was a failure to produce properly working components and program failures.[700] Ultimately Dhia accepted that his management style was cumbersome and accepted the formation of "zumra" or multi-disciplinary teams to work on problems.[701] But that occurred in 1987, five years after the program's initiation.

Within the EMIS program, Jafar Dhia also superimposed his ideas on the project. He insisted on a new Penning Ionizing Gauge (PIG) ion source as the heart of the EMIS

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[698] Obeidi and Pitzer, "The Centrifuge," pp. 53-54.
[699] Khadduri, "Nuclear Bomb," p. 83.
[700] Hymans, "Spinning in Place," p. 99.
[701] Khadduri, "Nuclear Bomb," pp. 89-90.

process instead of relying on the tried and tested Calutron technology, which was used during the Manhattan Project and then discarded because it was considered too inefficient. Many of Jafar's scientific colleagues opposed the PIG process. In 1987, the program failed spectacularly, after which it was abandoned in favor of the Calutron method.[702] In the absence of agent competition and the stove piping of all information via Jafar, Saddam and his henchman however were unaware of the dissent within the team until the failures mounted.

The alternative Gas Diffusion method also proved unsuccessful. The method required highly advanced compressors and machines to push uranium hexafluoride (UF6) gas through metal barriers. These were unavailable domestically and subject to export control laws in the international market. The Iraqi scientists were afraid that attempts to make purchases abroad would alert foreign intelligence agencies to Iraq's nuclear quest. The chief Iraqi scientist Obeidi who was in charge of the program considered the program a scientific exercise and a technology demonstration project at best. Between 1982-87, all his team came up with was a prototype barrier with two compressors.[703] This program, like the EMIS program, was directly under Saddam's supervision. But like with most leaders he could not give sufficient personal attention to the program. In the absence of an independent monitoring body that could provide oversight and redress the problem of information asymmetries, Saddam also remained uninformed about the program's lack of progress until 1987.

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[702] Hymans, "Spinning in Place," pp. 100-102.
[703] Obeidi and Pitzer, "The Centrifuge," pp. 54-56.

Confronted by these multiple failures, in 1987 Hussein Kamal, Saddam's son-in-law, assumed personal charge of the program and tried to revive it through the gas centrifuge uranium enrichment process. But in this program too the Iraqi nuclear team tasked with developing centrifuge technology worked in isolation. Without recourse to international assistance, the scientists started with a sequential trial-and-error method involving the World War II-era Beams centrifuge.[704] Within a few months, the scientists and engineers realized the technology was incapable of yielding weapons-grade uranium. Next, they switched to maraging steel centrifuges and with Kamel's acquiescence ended Saddam's original stipulation of not seeking help from abroad. When this program ran into difficulties, the centrifuge team switched to developing carbon-fiber "super-critical" centrifuge technology.[705] For the latter two programs, the Iraqi team successfully recruited vendors and consultants from Germany, Switzerland and Austria. Thanks to foreign assistance the program saw some success.[706] Between 1987-1990, the Obeidi's team was successful in demonstrating the technological feasibility of the project.

The problem with the centrifuge enrichment program, like other programs within the Iraqi state, was that it operated in near isolation. Jafar and Obeidi's teams did not talk to each other with highly negative consequences for the program. Thus even while the centrifuge program proceeded apace, there was a lack of coordination between the two teams on the production of UF6, the critical feed required for the centrifuges.[707] This had highly negative consequences for the weapon program. In 1990 for example, Saddam and Kamel initiated a crash weaponization program in anticipation of the coming war with the US. To build a

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[704] Obedi and Pitzer, "Saddam's Grip," *The Bomb in My Garden,* pp. 67-86.
[705] Ibid, pp. 87-98.
[706] Obeidi and Pitzer, "Shopping in Europe," *The Bomb in My Garden*, pp. 99-118.
[707] Obeidi and Pitzer, "The Crash Program," *The Bomb in My Garden,* p. 136.

weapon, they ordered a grab of the enriched uranium held by Iraq under IAEA safeguards. Their goal was to use a pilot centrifuge facility to enrich the uranium further to weapons-grade. Although Obeidi's team was able to set up a small pilot facility, Jafar's team was unable to produce the UF6 to feed the centrifuges.[708]

There were four groups within Iraq who were working on the nuclear weapons program. Group 1 and 2 worked on uranium enrichment. Group 3 provided administrative support while Group 4 was in charge of the weapon design.[709] By 1990, Groups 1 and 2 had produced 5gm of weapons-grade Uranium-235. The total minimum required for a Hiroshima-type weapon was 18-20kg.[710] The bomb itself was a paper design. Group 4 had not developed the explosive lenses required to trigger detonation. Neither was any 'cold test' performed until then. At that point the delivery system and its guidance system were still under consideration.[711] Despite the high-centralization, the entire program was compartmentalized and suffered from weak intra-institutional linkages. The principals were not only blindsided by the information asymmetries that worked against their favor, but were also generally oblivious of the challenges of managing their agents successfully. Such was the compartmentalization within the program that when international inspectors came calling after the Gulf War, the Kamal Hussein's Special Security Organization carted and stashed away documents, plant machinery and lab equipment related to the weapons program without consulting the scientists.[712] According to Iraqi scientists, this last act of

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[708] Ibid.
[709] Khadduri, "Nuclear Bomb," pp. 90-91.
[710] Ibid., p. 121,
[711] Ibid.
[712] Obeidi and Pitzer, "The Crash Program," pp. 139-140.

disaggregation would have made the program extraordinarily difficult to revive, even if Saddam had subsequently decided in its favor.

Revisiting Secrecy in India

The above cases suggest that regimes of moderate and low secrecy, both external and internal, have negative effects on the management of large technology projects. Yet, those negative effects do not prevent parallel processing and institutional oversight within the state. Regimes of high internal and external opacity however jeopardize institutional oversight and lead to poor management practices. The logical next question then is: what causes variation in the regime of secrecy. Why do some states adopt regimes of medium and low secrecy when others follow practices of severe opacity? More pointedly, what caused successive Indian decision-makers and governments to favor extreme versus moderate secrecy? Why did Indian leaders forego the legendary institutional oversight for which the Indian bureaucracy is famous?

There are three hypotheses that potentially explain India's behavior.

The first is variation in external pressure from the US, the chief enforcer of the nonproliferation regime. In this regard, the French, Israeli and Pakistani cases are a time-lapse mechanism, which capture the changes in the US approach to proliferation over four decades. Since President Eisenhower first announced the Atoms for Peace program in 1953, US opposition to proliferation in the international system has grown. However, in the case of US allies, nuclear nonproliferation has rarely occupied the top rung of the foreign policy agenda. The evidence shows that although the US sought to lobby and push its allies against

the acquisition of nuclear arms, successive US administrations did not exercise sustained pressure to either threaten them militarily or disrupt their economic or security interests. The absence of serious international pressure in turn permitted France, Israel and Pakistan to pursue their nuclear programs with relative impunity. Although each state conducted its nuclear program in secrecy, the secrecy was never sufficiently acute to jeopardize institutional controls within each state.

In contrast, US nonproliferation pressure on India was more sustained, especially after India's exploited the dual-use technologies route to conduct a "PNE," which contained within it the seeds of a weapon program. Prior to India's test, the US actively assisted India with acquiring the complete nuclear fuel cycle. It did not insist on full-scope safeguards as a condition for the supply of critical technologies and equipment. The Indian test, however, caused a sea change in US nonproliferation policy. It became the trigger for the enactment of tough technology export control regimes – the Zangger Committee and the London Suppliers Group. It also provided the push in the US Congress to enact tough domestic nonproliferation legislation against countries such as India, which did not renounce nuclear weapons and accept full-scope safeguards. In the two decades and a half following the 1974 test, the US used both measures to cripple India's nuclear power sector effectively. By threatening India's other sectors such as space, computing, electronics and high-tech industry in general and by also seeking to deny India international financial aid and loans through World Bank and IMF, the US became instrumental in forcing India's weapon program underground.

Nonetheless, the US did not threaten India with military action. Nor did it seek to sabotage equipment and facilities; or threaten the lives of Indian scientists working on the weapon program. Compared to Iraq where Israel destroyed the Osiraq reactor and assassinated its scientists or Libya against which the US launched air attacks, the threats to the Indian nuclear program and its economy were relatively benign. Thus external pressure may not be a complete answer to Indian paranoia and secrecy. There may be other domestic factors that in their interactive effects with external pressure shaped India's institutions of secrecy in the pre-1998 era. Regional specialists speculate that the Indian state's unusual proclivity toward secrecy is the path dependent legacy of British colonial rule. During the colonial era, the British classified information in a blanket manner to protect imperial interests. The post-colonial Indian bureaucracy inherited that institutional legacy and has continued it to protect the interests of the ruling regime. Indian government rules mandate routine declassification of documents after 20 years. However, the government has used arbitrary national security classifications to staunch routine declassification in the areas of foreign policy and defense.

Further, the nuclear weapons program in particular is embedded within India's "strategic enclave," the complex consisting of nuclear, space and defense industries, which operates as a state within a state. At the launch of the nuclear program the Indian government deliberately institutionalized the program as a semi-autonomous complex removed from collaborating with universities or private industry. This decision was disputed by a section of India's political class and the scientific community who regarded such institutional practices as inorganic and even more draconian than the secrecy laws then instituted in the US and Britain at the time. Successive Indian governments stuck with their initial decision and tightened secrecy laws even further citing dual-use national security reasons. Among other

reasons, the creation of autonomous high-tech enclaves within the state was justified as a means to jump start Indian science by removing the state's standard bureaucratic oversight mechanisms, which are associated with "red tape" and inefficient outcomes. In the case of India's nuclear sector, as the program failed to keep up its stated promises and as accidents and environmental damage resulted from weak institutional controls, the atomic bureaucracy raised the barriers to accessing information even further. Eventually, even the weapons program, the jewel of India's nuclear establishment, was left bereft of institutional oversight despite the high centralization and priority that was accorded it.

Finally, secrecy may have normative-reputational roots but not in the manner historically understood in the context of Indian decision-making. Scholars have generally attributed Indian nuclear hesitancy to the beliefs of its leaders in norms against the acquisition of nuclear arms. Four Indian prime ministers in particular, Nehru, Shastri, Desai and Rajiv Gandhi were opposed to nuclear arms, some more unequivocally than others. However, Indian prime ministers, even those opposed to a nuclear weapons program, also pursued a Janus-faced strategy, publicly opposing India's acquisition of nuclear arms while permitting weapons-related work to proceed in secret. Other prime ministers such Singh, Rao, Gujral and Gowda demonstrated lesser normative predilections. But they chose to pay lip service in public to such norms. It is thus possible that Indian prime ministers pursued secrecy for reputational reasons, because of their own or their predecessors' normative commitments in public.

Whatever the causes of India's institution of extreme secrecy, its consequences should not remain in doubt. Secrecy stymied organizational learning within the state and cocooned

Indian decision-makers in a regime of relative ignorance. Several technical lacunae in India's current operational nuclear capabilities are the legacy of this institution. Short of upending the status quo entirely, they are likely to remain embedded in the operational DNA of India's nuclear force.

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SCHEMATIC 1

IMAGINED ORGANIZATIONAL SCHEMATIC OF OPTIMAL DECISION-MAKING

PRIME MINISTER
Cabinet Committee on Security
Defense * Foreign Affairs * Finance * Home

STRATEGIC POLICY PLANNING GROUP
- Cabinet Secretary
- National Security Advisor
- Principal Scientific Advisor to Prime Minister
- Scientific Advisor to Defense Minister
- Chairman, Chiefs of Staff Committee
- Director, Research & Analysis Wing
- Chairman, Atomic Energy Commission

STRATEGIC ARMAMENT AUTHORITY
- BARC
- DRDO
- CoSC

Independent Technical Advisory Board

SCHEMATIC 2

ORGANIZATIONAL SCHEMATIC OF ACTUAL INDIAN DECISION-MAKING (1970-1998)

PRIME MINISTER
Cabinet Committee on Security
Defense * Foreign Affairs * Finance * Home

STRATEGIC POLICY PLANNING GROUP
- Cabinet Secretary
- National Security Advisor
- Principal Scientific Advisor to Prime Minister
- Scientific Advisor to Defense Minister
- Chairman, Chiefs of Staff Committee
- Director, Research & Analysis Wing
- Chairman, Atomic Energy Commission

STRATEGIC ARMAMENT AUTHORITY
- BARC
- DRDO
- CoSC

SCHEMATIC 3

INDIA'S HIGHER DEFENSE ORGANIZATION

Cabinet Committee on National Security
Prime Minister
Home * Finance * Defense * Foreign Affairs

Secretary to Prime Minister	Cabinet Secretary	**National Security Advisor**

National Security Council

Strategic Policy Group

Ministry of Defense

National Security Council Secretariat

Secretaries: Defense * Defense Production * Defense Finance * Defense R&D

CDS **Chiefs of Staff Committee**	Army Headquarters	Air Force Headquarters	Navy Headquarters

Integrated Defense Staff

Strategic Forces Command