DEFENCE AND DEVELOPMENT : INDIA'S QUEST FOR TECHNOLOGICAL SELF-RELIANCE

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CERTIFICATE

Certified that the dissertation entitled **"Defence and Development : India's Quest for Technological Self-reliance"**, submitted by Anita Dey is in partial fulfilment of nine credits out of a total requirement of twenty four credits for the award of the Master of Philosophy of this University. This dissertation has not been submitted for the M.Phil. Degree of this University or any other University. This is her own work.

We recommend that this dissertation be placed before the examiners for evaluation.

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F O R M Y P A R E N T S

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PREFACE

(Knowledge has always conferred power on those who have it and know how to use it. Practice has shown that those who produce and possess technology have, if they choose, enormous power to influence and control international relations.

Science and technology will always remain a decisive factor in determining the qualitative level of both defence and development. The goal of every nation is to attain technological self-reliance. In the ultimate analysis, self-reliance means the ability to provide for one's security. (For developing countries like India, that demands development so as to create a modern and self-reliant economic, industrial and technological system. But development in turn, requires security for its accomplishment.) It is in defence that one fundamentally confronts the inescapable paradox in the aspiration for technological self-reliance.)

The thrust of this dissertation is to identify the role of science and technology in defence and development ; and to analyse India's efforts at building a self-reliant scientific and technological base in her bid to achieve self-reliance in defence.

The objective of this tract is not to arrive somewhere new, but, in the words of T.S. Eliot, 'to arrive where we started and know the place for the first time'.

I should like to put on record that this dissertation could not have conceivably been completed without the help, guidance, inspiration and patience of my supervisor, Prof. M. Zuberi.

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CHAPTER ONE

DEFENCE AND DEVELOPMENT : ROLE OF SCIENCE AND TECHNOLOGY

(Acquiring arms was one of man's highly valued endeavours even during the times of his most archaic existence. Arms assured him of his security and survival and also gave him the power and authority to influence and dominate others. Man's evolutionary transformation from his primitive state to a more cultured and civilised world, from a nomadic existence to organised social and communal living, has not brought about any fundamental change, either in his instincts for security, survival and domination, or in the expression of such instincts through the endeavour to acquire arms. Of course, the form and magnitude of this endeavour have undergone radical changes as a result of technological advances. Arms are now more varied and sophisticated. The arsenals are huge and deadly. The expressed purpose is no longer individual safety alone but 'national security'.

(Today 'national security' has come to assume a multidimensional character and can no longer be equated to only military might. National security constitutes the political military component of protecting territorial integrity and national sovereignty, and the economic component of promoting socio-economic development: improving living standards by increased production and equitable

distribution[1].

Perceived threats to national security may, therefore, have internal and external dimensions which come in diverse forms that cannot be easily weighed against each other, and are frequently in a state of constant evolution. All states are to some degree vulnerable to military threats and economic threats and many also suffer from fundamental political insecurity[2]. Moreover, the nature of national security is as diverse as the conditions of the different states to which it applies. This is because states differ in size, power, physical geography, relative location, character of population, resources, domestic, political, economic and social structure, and degree of independence[3].

National security is central to the debate on Defence and Development which in turn is influenced by progress made in the fields of science and technology.

Defence has normally been accorded highest priority in national security concerns, because the behaviour of states

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1. Bruce E. Arlinghaus, "Social versus Military Development : Positive and Normative Dimensions", in James Everett Katz, ed., Arms Production in Developing Countries, (Toronto, Lexington Books, 1984), p. 40.

2. Barry Buzan, People, States and Fear : The National Security problem in International Relations, (New Delhi, Transasia Publishers, 1983), p. 65.

3. Ibid.

and the dynamics of their relations with each other are strongly affected by military factors. Defence is a top national priority with all the developing countries, almost all of whom attained independence from colonial status after World War II. The most important factor driving developing countries to have their own defence programme, can be summarised quite easily: "autonomy, that is, freedom of action in the domestic and international spheres".[4] For any nation, being in the position of having some other nation choke off needed arms supplies in order to get it to alter its behaviour is unacceptable. Most nations will go to great lengths to preserve their policy options[5]. The U.S. or the USSR are no different from India, Israel or Argentina.

Developing countries are not different from the U.S. in terms of motivations, only in resources. Motives are one thing but the actual ability to carry out an arms production programme is another. For a developing country to have its own defense programme would involve the mobilisation of enormous amounts of capital as manifested in infrastructure, specialised materials and technical know-how. Above all, it

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4. James Everett Katz, "Arms Production in Developing Countries, in James Everett Katz, n.1, p.4

5. Ibid., p. 5

must possess an indigenous industrial capacity. Defence spending, therefore, puts a great strain on the financial resources of developing countries. Moreover, being in the midst of the development process, threats to their security are greater. Development, no doubt, contributes to better defence preparedness. But development efforts will be futile if a country cannot be protected from outside aggression. Hence defence and development are very closely inter-related, particularly in developing countries.

"Development reflects national capacity, and combines the economic notion of aggregate wealth with the political notion of control over that wealth. It provides an index of potential power, that is, an upper bound on the capacity of a state to mobilise resources for whatever purpose, military or civil, when the need arises".[6] "In its broadest sense, development refers to social and economic changes in society leading to improvement in the quality of life for all. At the most basic level, it means providing for every person the basic material requirements for a productive and dignified existence. Economic growth, that is, the expansion of output, is a pre-requisite for sustained development but development cannot be reduced to economic

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6. A.F. Mullins Jr., Born Arming : Development and Military Power in New States, (USA, Stanford University Press, 1987). pp. 65-66.

growth. Development means that everyone should have the opportunity-and with the opportunity, the responsibility - to participate fully in the economic and social process and to share in its benefits. More specifically, if the global development effort is to be morally and politically sustainable, it must endeavour to provide for a pattern of economic growth that would significantly diminish within a reasonable time frame the prevailing disparities between states in the quality of life".[7]

Development, therefore, is an all-pervasive activity which transcends national boundaries. Development of a state - military or economic - cannot take place in isolation. This is necessarily so, for states do not function as isolated autonomous entities, but are embedded in an international system whose chief characteristic is the struggle for power, with the economically and the militarily strong dominating over the weak.

The defence and development issue stems from the premise that the political-military aspects of defense are often seen as competing with or contradicting the economic

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7. The Inga Thorsson Report on the Relationship between Disamament and Development, U.N., 1982, in MacGraham, Richard Jolly and Chris Smith, eds., Disarmament and World Development, (U.K., Pergamon Press, 1986), pp.234-235.

aspects of development. But this is a false opposition; "virtually all nations, whether developed or developing, have chosen mixed strategies of social and military development"[8]. The social and military sectors compete for scarce resources, but neither is in reality, perceived as being a less valid requirement than the other. Environmental factors - such as threat perceptions, recent conflicts and so on - will in large part determine the priority that each of a wide variety of social and military needs will have during a given time period[9].

One reason for these choices taking the forms they do is the continued perception that some type of security is a precondition of stability, which in turn is a precondition of development. Social and economic development is a pre-requisite, not only to remove the sources of internal instability that threaten national security and the overall development process, but also to create the industrial base necessary for the development of indigenous defence industries.[10]

The defence versus development argument presumes that "monies spent on defence are by definition not spent on

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8. Bruce E. Arlinghaus, n. 1, p. 40

9. Ibid.

10. Ibid., p. 43.

development and, therefore, represent a misallocation of resources".[11] It is tempting to claim that there is a causal link between the growing allocation of resources to defense and the persistence of underdevelopment. After all, military spending is the prototypical 'unproductive expenditure' from a socio-economic point of view. It might be assumed to follow that defence spending must, therefore, reduce growth and endanger development - but the notion is simplistic![12] If the focus of interest is on the third-world context, then economic growth should be divorced from development. "Economic growth is usually interpreted to mean increases in the level of national income. For comparative purposes a per capita index of the average rise in the national income is employed. Economic development is somewhat different. It is a nebulous concept, having relevance to the quality of life. Proxies are used, such as infant mortality rates, nutritional intake, and access to higher education, as a means of evaluating the degree of development".[13]

Although numerous studies have suggested that defence spending can and does have an impact on economic

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11. Ibid., p. 41.

12. Saadet Deger and Robert West, eds., Defence, Security and Development, (London, Frances Pinter, 1987), p. 2.

13. Ron Matthews, Defence Production in India, (New Delhi, ABC Publishing House, 1989), p. 24.

performance, there is no consensus about the actual existence and nature of such an impact. Perhaps the most celebrated study in this area is that of Emile Benoit, who conducted a cross-sectional analysis of 44 LDCs for two overlapping periods of time. The first time-series, which he labelled A series, showed no correlation between defence spending as a percentage of GNP and the growth rate of civilian GNP. However, Benoit's C series, covering the 1960-65 period exhibited a significant positive relationship between the two variables. He stated that "the evidence pointed strongly to the conclusion that, whether or not defence activities (i.e. spending) had had a favourable net effect on growth in the sample countries, they had certainly not had an unfavourable one".[14]

But Stephanie Neuman, another participant in this debate argues:[15]

> There is as little evidence available to support the conclusion that military expenditure have negative consequences as there is for the opposite position. Although the observed rise in military expenditures is used to explain militarism, economic stagnation,

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14. Steve, Chan, "Impact of defence spending on economic performance: A survey of evidence and problems," Orbis, Philadelphia, Vol. 29, No. 2, Summer 85, p. 409.

15. Ibid., p. 410.

> instability, war, dependence and a slower rate of economic growth, it must be pointed out that no empirical relationship between the variables had as yet been established.

It is not easy to quantify the effect of defence on development. There are difficult definitional problems and the choice of a suitable aggregate index to define development is problematic. "The milieu of development is comprised of domestic and external milieu, and the components of development are its values, structures and processes. It is futile to indulge in empirical exercises to measure things like values, the understanding of which is crucial in the process of development".[16] It is now widely acknowledged that GNP is a misleading indicator even of economic growth, let alone of economic development. It does not give us any idea either of the political or of the actual development, as it is a highly dependent variable.

In urging third-world countries to emphasize development narrowly for economic welfare while discouraging them from establishing the foundations of national power, especially an independent arms industry and most particularly nuclear power, Western nations perhaps seek to

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16. S.D. Muni, Arms Build-up and Development : Linkages in the Third World, Canberra Papers on Strategy and Defence, no. 22, (New Delhi, Heritage Publishers, 1983), p. 32.

maintain their advantageous position in the international system under the garb of world order concerns.

In fact, arms build-up in the third world has not been an isolated, self-generated and self-contained process. It is an inherent part of the international system and has been conditioned by the ethics, values and impulses of the wider system. Following from this is the argument regarding "Disarmanent and Development", which is at a much higher level of generalisation than "Defence versus Development". It is directly related to the debate on the new international economic order (NIEO) and the redistribution of wealth from the rich to the poor nations. The essence of the argument is that the "wealth currently squandered by the industrialised nations on weaponry represents precisely the most fungible source of funds to finance international development and a redistribution of wealth from the North to the South".[17] This is an emotionally and politically charged issue, especially since it is the perception of many developing nations that the military superiority of the North, together with the transfer of arms and military technology, forms the basis of their contained dependence and subordination to it.[18] Ironically, at the same time as

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17. Bruce E. Arlinghaus, n. 1, p. 42.

18. Ibid.

they call for the reduction of arms expenditures world-wide, and a programme of global disarmament, developing nations insist on the right to continue to arm themselves. "But the point is very simple: not only is security or defense necessary as a pre-condition for economic development, it is also a vital pre-requistite for the continued existence of many third-world countries. Their leaders recognise that defence expenditure might be better spent on development, but only in a perfect world in which defence is unnecessary".[19]

Whether it is military expenditure or economic performance, both are regulated according to a country's development level and its resource base. The one important factor that determines the level of defence and development is humanity's command over science and technology, a process deeply and self-sustainingly rooted in human society.

It would be pertinent to distinguish between science and technology at the very outset. In brief, technology is "know-how" while science is "know-why". Science produces knowledge, technology helps to produce wealth.[20]

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19. Ibid.

20. Graham Jones, The Role of Science and Technology in Developing Countries, (London, Oxford University Press, 1977), p. 5.

Historically, science has been more dependent on technology than vice-versa and only recently have science-based industries come to the fore. Even now they must be regarded as mainly separate streams, with a limited though increasing interaction. In either, "growth tends to depend on the state of the art of each separately, with old technology breeding new technology and old science breeding new science.[21] There is, however, a symbiotic relationship between them - 'Science without the byplay of technology becomes sterile' while technology without science become moribund".[22]

Science is available in a world-wide system of publications, accessible to anyone who is trained to use it. Technology, is not so readily accessible, partly because of industrial secrecy and property rights, but also because technology must be learnt by doing.[23] It is embodied experience, and is inherently much more difficult to transfer. In the development of biological natural resources, technology is essentially dependent on the environment, and hence must be devised to suit each ecological situation.[23] Science is, therefore, universal;

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21. Ibid.

22. Ibid., p. 6.

23. Ibid.

technology has to be "appropriate" to human needs, resources, geographical conditions, in order to be beneficial.)

The material wealth of a country depends on the production of goods and services through the coordinated use of available supplies of human skills, capital, land and natural resources. Economic growth can stem from greater production through the more efficient use of resources. Technology contributes to both aspects, through increasing the utility of available resources and by productivity improvement through increased skills, better method, and better machines. Science provides the pool of basic knowledge and understanding on which technology increasingly depends.[24] Technology, in the sense of knowledge organised to do a task, therefore, plays a major role in economic and social activity.[25] (Indeed, the material levels of living, the character of social and cultural life, and the security of societies have always been closely related to the technologies they used.) But the occurrence of the Industrial Revolution, first in Britain and its subsequent

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24. Ibid., p.4

25. Ashok Parthasarathi, "Science and Technology in our search for a sustainable and just future", unpublished paper at a Seminar on Nation-Building, Development Process and Communication: A National Seminar in Search of India's Renaissance, held at Vigyan Bhawan, New Delhi on 3-7 December, 1988, p.1.

spread to other parts of Europe, and then to the USA, Japan and the USSR, led to technology coming to occupy centre-state in the development of nations. It is not surprising therefore that the technological backwardness consciously preserved in the countries under colonial rule was a major concern of their independence movements; this led leaders of such movement to voice their concern for rapid technological advancement.[26]

Underlying this view was the conviction, based to some extent on history, that what distinguished a poor country from a rich one, a strong country from a weak one, was 'modern' technology. At the same time, there was the associated stream of historical analysis of how predominantly agrarian societies transformed themselves into industrial societies, from societies based on subsistence agricultural to high productivity agriculture, all of which led to the spotlight being put on industrialization.[27] The combination of these two streams of thinking led to a focus on industrial technology in the economic development of the newly independent countries of the world. Consequently from the time they came to acquire political independence these countries of Asia and Africa set out to industrialise

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26. Ibid.

27. Ibid., p. 2.

themselves drawing upon industrial technologies from the highly industrialised countries.

However, economic arguments are not usually sufficient to justify the undertaking of technology development. There must be some reason that transcends purely economic considerations, and in the majority of cases that reason has been national security and the use of national defense as a spur for technology development is natural for a number of important reasons. It has been recognised for many centuries (even millenia) that technical superiority means victory in war. National security and national defense are permanent objectives.[28]

The character of threats to national security does not remain constant over time, but changes in response to both new developments in the nature of threats, and to changing balance of power which alters the nature of vulnerabilities of states.[29] Raymond Aron refers to this phenomenon as the 'law of change' which means that "the military, demographic or economic value of a territory varies with the techniques

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28. Baldev Raj Nayar, India's Quest for Technological Independence, Vol. I., (New Delhi, Lancers, 1983), p. 31.

29. Barry Buzan, n. 2, p. 86.

of combat and production, with human relations and institutions." Military technology especially provides an illustration of this point.[30] Weapons of a certain type are characteristic of any given historical period, and the particular capabilities of these weapons largely define the nature of military security problems which states face at that time. Unless defenses are continually evolved to meet new capabilities, military security deteriorates rapidly.

Beyond its recognition as a factor of economic growth, technology moved to the forefront of national considerations because of its role in World War II. New military technological developments - such as the radar and the atomic bomb - were critical in reversing the tide in the war and finally bringing it to a conclusive end in favour of the allied powers. The end of World War II saw the United States' emergence not only as the hegemonic super power in the world, but as the foremost technological power. Technological leadership was now seen essential to political leadership in the international system.

"Science and Technology have contributed to the unification of mankind through the techniques of production, transportation and communications. Humanity for the first

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30. Ibid.

time is experiencing a common history. The dialectics of equality and universality and the promise of abundance demand an egalitarian order".[31] (The spread of technology drives the world towards a common culture; "the global diffusion of modern technology tends to standardize the 'existence rationality' of all societies around specifically western notions of efficiency, rationality and problem solving".[32]) But whereas modern values grew organically with the slow and gradual development of industrialization in the West, the underdeveloped countries confront sharp and radical discontinuities in the juxtaposition of modern and traditional values. Science and technology constitute but one factor of change. (In most developing countries, the social and cultural traditions are often positive barriers to change.[33] For science and technology to make effective contributions, it is necessary to facilitate extensive and intensive changes in human values and attitudes.)

(Technology is no static phenomenon; it is constantly changing, bringing forth new products with amazing rapidity

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31. M. Zuberi, "Disarmament and Development", World Focus (New Delhi), Vol. 9, No. 8, August 1988, p. 3.

32. B.R. Nayar, n. 28, p. 25.

33. Graham Jones, n. 20, p. 7.

and newer and more efficient processes of production, improving some and outdating others.) Thus, one of the major problems that the world faces is the "technological gap" between the developing and the developed countries. Developed countries not only have the base and momentum but also strong and extensive socio-cultural traditions in developing, implementing and accepting technology. The necessary infrastructure to support expanded technological development exists, with a resource base and industrial capacity for expansion. Developing countries on the other hand, lacking a comprehensive industrial infrastructure, require technology and centralised decision making with respect to technology, in their drive toward modernising their economies.[34]

If the key motivation for industrialization is economic and political independence then third-world countries are faced with a profound paradox in that the sources of technology to make industrialization feasible lie in the developed countries. Therefore, efforts to industrialize have led to increased technological dependence. Moreover, even as some third-world countries succeed to a certain extent in establishing industry, the constantly changing

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34. Technology Assessment for Development, Report of the U.N. Seminar on Technology Assessment for Development, 1978.

nature of technology imposes newer types of constraints on their independence. The instrument of domination is now, more than military and political power, the scientific and technological superiority of the advanced countries.

Though the basic purpose of the developing countries in importing technology is to gain time and save resources, dependence on foreign technology may seem counter to their national interests. First, technology can be inappropriate in relation to the resource endowment of the developing countries. Being capital intensive and skill-intensive, it may not be suited to the developing countries with labour surpluses and capital scarcity. The inappropriate nature of foreign technology may have a devastating impact on the local R & D structure. It results in the "alienation" of science from production, which is based on technology imports, and a consequent "marginalisation" of science in the economy and society.[35] The science and technology (SAT) apparatus is basically delinked from the production system, which makes no demand on the SAT system, therefore giving no incentive for the local SAT system to produce.[36] Lack of productivity in the SAT system leads to continued technology imports. This can have important implications. Present

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35. B.R. Nayar, n. 28, pp. 46-49.

36. Ibid.

decisions may foreclose future options and establish immutable courses of action. Import of technology necessarily results in economic and possibly political dependency. Therefore, "self-reliance" as a strategy for developing countries becomes crucial in their bid to protect independence. Self-reliance in scientific research and technology development needs to be considered against the background of the current store of technological knowledge available in the contemporary world and the level and perspective of scientific development in the developing country. It would obviously be unwise to reinvent the wheel merely to satisfy the otherwise laudable urge for self-reliance. In developing countries, time is the greatest hurdle and we must do in a few years what the developed countries have taken a few decades to achieve. Our problem is not only to bridge the technological gap but also halt its widening.[37]

Therefore, self-reliance in technology, means that a nation has the knowledge, skills, and innovative productive capacity within itself to remain aware of the latest technological developments and their implications, and develop indigenously or import/adapt/upgrade technology to

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37. V.K.R.V. Rao, Values and Economic Development : The Indian Challenge, (Delhi, Vikas Publications, 1971), pp.22-34.

meet its national needs of defence and development appropriately linking its industrial and economical infrastructure in the process.

India made great strides since 1947 in industrialization, agricultrual growth and in the development of a science and technology infrastructure. Forty years of development have given to India segments of industrial production that are the rough equivalent in quality and sophistication to any in the world. Though India has her share of fundamental economic problems of growing population, poverty, unemployment, this has not prevented her from building large modernised defence forces supported by a self-reliant industrial base.

The following two chapters deal with India's efforts, since independence, in building a science and technology infrastructure to support a self-reliant defence programme, with a concluding chapter on how far has India been successful in her quest for self-reliance in technology.

CHAPTER TWO

QUEST FOR SCIENTIFIC AND TECHNOLOGICAL SELF-RELIANCE

Economic, technological and military competence are factors that contribute to the self-reliance of a nation. A country with technological competence and economic strength would probably have created an industrial infrastructure that could be utilised for building and sustaining an adequately self-reliant defence industry. It would, therefore, be logical to study how India, from a colonial status, has been successful in building a self-reliant industrial-technological infrastructure to support an independent defence industry.

The primary task of newly independent India was rapid industrialization and social development. What the state needed was an era of peace to enable her to set the foundations for self-sustaining economic growth, self-reliance and economic independence from other powers. Nehru, the architect of modern India, believed that steering clear of military alliances in the Cold War would reduce military danger and enable India to concentrate on her economic development. This was translated into a foreign policy of "non-alignment" and peaceful "co-existence".

Accordingly, India's external policies searched for ways to advantageously manipulate the country's role and position between the competing socialist and non-socialist

sectors of the international system. "While avoiding any formal commitments, beneficial channels of communication were opened with both the groups of states to allow for the transfer of technology, funds and resources in support of India's economic development. Most importantly, Indian policies attempted to sanitize the level and intensity of interaction with either group according to Indian preferences.[1]

In order to sustain national independence and foreign policy autonomy, it therefore became essential for India to provide a substantial independent industrial base and arms industry. Flowing from that also was the necessity to back up the strong industrial base, with a vigorous science and technology policy.

India sought to give direction to her programme of industrialization through a policy of planning based on the socialist pattern, initiated primarily by Nehru. In 1950 with the appointment of the Planning Commission, India ushered in an era of planned development and obviously science and technology became important components for

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1. Onkar, Marwah, 'India's Military Power and Policy' in Onkar, Marwah and Jonathan Pollack, eds., Military Policy and Power in Asian States : China, India, Japan, (Boulder, Colarado, Westview Press, 1980), p. 110.

development and for attaining self-reliance; and self-reliance was not possible unless science and technology were closely merged with the whole strategy of planning.

Nehru's industrial - technological model reasoned that although an industrial system built on the basis of indigenously developed technology was ideal, given the absence of a capital goods base and the utter lack of research and development capabilities within the country, this would be a long drawn-out and time consuming process. Hence, the creation of a self-reliant industrial system was to be based on a liberal import of technology rather than locally generated technology. Where feasible, India went for the licensing of such technology but, where necessary, foreign investment was allowed, especially given the shortage of foreign exchange resources.[2]

According to Nehru, there were three fundamental requirements for India's development: "A heavy engineering and machine making industry, scientific research institutes, and electric power". He added: "These must be the foundations of all planning".[3] The broad framework of

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2. B.R. Nayar, India's Quest for Technological Independence, Vol. I, (New Delhi, Lancers Publishers, 1983), p. 135.

3. Ibid., p. 181.

Nehru's model in relation to development of science and technology implied four major policy directions:[4]

1. A broadfront licensing strategy involving a massive import of foreign technology through the wide-ranging net of foreign collaborations.

2. The rapid creation of a broad-based general-purpose structure of R&D through a wide network of high quality science laboratories in the public sector.

3. The rapid creation of specific mission-oriented institutions for R & D in selected areas where generation of local technology is necessary.

4. A drastic increase in scientific and technical manpower - to service the industrial system based on imported technology as well as the R & D structure through a rapid expansion and upgrading of the system for higher education.

Thus, Nehru through the first three Five Year Plans pursued, a policy of industrialization with emphasis on heavy industry through a gigantic programme of import substitution marked by "selective disengagement". For the

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4. Ibid., pp. 242-243.

implementation of this programme, reliance was placed on technology import through broad-front licencing and considerable foreign investment because India did not possess either the requisite technology or the technological capabilities to generate it. Nehru simultaneously established a substantial R & D infrastructure as a potential basis for technological self - reliance in the future.

It would be pertinent to mention here that the paramount need for industrialisation for development in the 1950s supported by a foreign policy requiring a minimum of defence spending, may be regarded as groundwork for India's future defence capabilities. In the words of Nehru:[5]

> A country which is economically strong, which is industrially developed, is much more in a position to defend itself than any other country, however, brave its people might be. The great countries today, from the point of view of military power or defence, are countries which have developed industrially, which have developed in the exploration of science and its progeny.

The process of industrialisation governed within a socialist framework was expressed in the two Industrial Policy Resolutions of 1948 and 1956. The Resolutions

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5. Ibid., p. 175.

demarcated the division of responsibility between the public and private sectors, with the former assuming greater control over industrial activities. All industrial activity was classified into three categories. The first comprised the so-called 'basic' industries which included iron and steel, heavy machine tools, aircraft and ship-building, railway transport and all defence and strategic industries and the development of these was to be the exclusive responsibility of the state. A second category of 'basic' industries was to be progressively taken over by the state but with room for private enterprise to supplement state industrial activity. The third category of 'remaining industries' was open to the private sector but subject to the right of the state to enter these fields if it so deemed appropriate.[6]

Nehru stressed that "industrialisation ultimately depended upon heavy industries". The heavy industry strategy embodied in the second and third Five-Year Plans was the instrument for the achievement of economic, and thus political and military, independence. In the Second Plan, 77.5 per cent of the allocation for industry and mining was for heavy industry. The Third and Fourth Plans envisaged

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6. Raju C. Thomas, The Defence of India, (New Delhi, Macmillan, 1978), p. 117.

the setting up of four new steel plants under the public sector in Rourkela, Durgapur, Bhilai and Bokaro.

The goal of a substantial push for heavy and machine-making industries was "self-reliance" so that the requirements of further industrialisation could be met from the country's own resources. The term self-reliance came into increasing usage since the Third Plan. The meaning of self-reliance was spelled out in the Fourth Plan:[7]

> Self-reliance not only means freedom from dependence on foreign aid but also involves the establishment of an acceptable minimum standard of living for the masses and a continuous rise in this standard. With self-reliance, therefore, has been linked the capacity for self-sustaning growth. This means that the objective is not only to take the country towards freedom from dependence on external aid for its economic development but also to generate domestic capacities that will enable it to have a steady and satisfactory rate of economic growth without dependence on external aid. This does not mean that we aim at economic autarky or that we shall be able to dispense with all imports. No country in the world is able to do so. What it does mean is that the country's requirements will be met from within to the maximum possible extent, and that what it must obtain from abroad will be limited to what it cannot produce within its borders or finds it uneconomic to do so in terms of comparative advantage, and even more important, that it is able to pay for these imports with its export earnings.

Following from the goal of self-reliance, India adopted a policy of "selective disengagement"[8] from the

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7. B.R. Nayar, n.2, pp. 168-169.

8. Ibid., p. 185.

international economic system, in so far as it involved an import - substitution programme of massive proportions, with the clear intent of having India through rapid industrialisation produce at home whatever it could. It was "selective" in two respects[9] : first the import-substitution strategy was based in great measure on import of technology rather than development of indigenous technology. Secondly, India's strategy of development and import-substitution relied in good measure on external resource - mobilisation. Given the poverty of the country, resources for investment were limited. The resource constraint was also felt in the area of foreign exchange; it became especially acute after the foreign exchange crisis of 1957. "In a sense one could say that technology policy in the 1950s and 1960s was solely determined by foreign exchange considerations, though the foreign exchange constraint was itself the result of the initial decision to go in for a gigantic import-substitution programme".[10]

However, to overcome the resource constraint, the government felt compelled to resort to the acceptance of foreign aid, despite the inherent risk to the country's freedom. But India attempted to diminish the influence of

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9. Ibid., p. 189.

10. Ibid., p. 191.

foreign aid dependence by pursuing a policy of diversification of its sources of aid, not only among the Western countries but across ideological blocs.[11] India was, therefore, able to enhance its bargaining power by playing off one bloc against the other. Through aid diversification, India was able to get from one bloc what was not available from or denied by the other. For example, when the US was resistant to providing for India's heavy industry programme, India obtained aid from the Soviet Union. The Bhilai and Bokaro Steel Plants were built with Soviet assistance.

Indeed, one can say in retrospect that India was engaged in an astute strategy that combined food and infrastructural aid from the US and heavy industry aid from the Soviet Union to subserve its larger programme of industrial-technological development with economic independence as the aim.[12]

Having triggered off the industrialisation process, India under the dynamic leadership of Nehru, simultaneoulsy accorded high priority to the building of a scientific

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11. Ibid., p. 194.

12. Ibid., p. 195.

infrastructure. The structure of science and technology in India today is primarily the result of the work of Nehru.

The importance the government of independent India attached to self-reliance in science and technology can be gauged from the drastic increases in the allocation of budgetary resources for the purpose. In 1948-49, the total sum of Rs. 11 million was spent on R & D in the Central Sector. By 1950-51 the Central Sector investment on R & D rose to Rs. 46.8 million.[13] Significant in this regard was the creation of the Department of Scientific Research in the Government of India and its subsequent expansion in 1951 into the Ministry of Scientific Research and Natural Resources for organising and directing scientific research for national development.[14] The enthusiasm with which the Ministry pursued the task of promotion of science and technology is borne out by its creation of agencies for research in specialised areas, strengthening of the existing ones, establishment of laboratories for research and development, and the involvement of scientists and technologists in advisory capacity with numerous committees on science and technology and industry. Further, each

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13. National Science and Technology Policy, Lok Sabha Secretariat, New Delhi, 1987, p. 3.

14. Ibid., p.4.

Five Year Plan document also emphasized the role of science and technology (S & T) in economic and social transformation of the country.

The central effort at building the R & D infrastructure was classified into two categories:[15] (a) general purpose R & D agencies and (b) mission-oriented R & D agencies. The pre-eminent agency in the first category is (1) the Council of Scientific and Industrial Research while those in the second category are (2) the Department of Atomic Energy (3) the Indian Council of Agricultural Research (4) the Defence Research and Development Organisation and (5) the Indian Council of Medical Research. These five major agencies represented the bulk of the central effort. It should be noted that, even when some of these agencies continued to have the same name as before independence, there was nonetheless a dramatic transformation of the effort represented by them, both financially and organisationally.

The Council of Scientific and Industrial Research (CSIR) was really Nehru's creation even though it had come into nominal existence in 1942 to boost Indian war effort in the global war. The CSIR became the largest scientific

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15. B.R. Nayar, n.2, pp. 308-309.

research agency in the country. Over 45 national laboratories and research institutes established by the CSIR fall into four major categories (1) Discipline-oriented laboratories such as the National Physical Laboratory and the National Chemical Laboratory. (2) Engineering laboratories pertaining to aeronautics, metallurgy and mining (3) Commodity laboratories (4) Multipurpose regional laboratories The CSIR became within the governemnt an institutional interest group that acted as a watchdog for the furtherance of indigenous technology. Though the CSIR was established to foster and coordinate scientific and industrial research, it has been characterised as lacking in "scientific technological inclusiveness" in that it does not incorporate more than a small part of the innovation chain.[16] It has often been alleged that the CSIR during Nehru's regime, despite some exceptions, basically failed in establishing a linkage with industry. But this may have been because of the belief that establishment of the R & D infrastructure would automatically result in linkage with industry.[17]

Nehru stressed that without enhancing India's scientific and technological capacity it could not be

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16. Ibid.

17. Ibid.

economically and politically independent. National security considerations were evident in Nehru's approach to expanding and organising India's infrastructure for scientific and technological research and development. The two principal innovations in the infrastructure were the establishment of the Department of Atomic Energy (DAE) and the Defence Research and Development Organisation.[18]

India was the first developing country to explore the uses of nuclear energy. The Atomic Energy Commission (AEC) was set up by Nehru in 1948 to apply atomic research to the generation of nuclear power. As controlling nuclear proliferation became a pre-occupation of industrialised countries, Nehru warned that "it might be to the advantage of (these) countries to retain and restrict the use of atomic energy to the disadvantage of a country like India".[19] The divergence between the interests of India and those of the industrial countries of Europe and North America in regard to the development of nuclear technology was brought into sharp focus in 1974 following the detonation of India's first atomic device.[20]

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18. Thomas Owen Eisemon, "Strategies for Enhancing Technological Capacities, in Martin Fransman and Kenneth King, eds., Technological Capability in the Third World, (London, Macmillan, 1984), pp. 269-270.

19. Ibid., p. 270.

20. Ibid.

The DAE encompassed within it a variety of research units, the pre-eminent one being Bhabha Atomic Research Centre (BARC) where the experimental nuclear reactors were housed.

A year after independence, Nehru created a defence science organisation and in 1953 a defence science service was organised under the then Defence Minister Krishna Menon. These were later merged to form the Defence Research and Development Organisation,[21] the functions of which are discussed in the following chapter.

The expansion of these scientific research agencies did not take place in a vacuum. Manpower planning for scientific and technical personnel were at two levels: at the level of general university education and at the level of professional and specialised training.

In 1958 the government, inspired mainly by the vision of Jawaharlal Nehru, adopted the Science Policy Resolution, which laid down the basic framework for the direction of science and technology in India. It declared:[22]

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21. Ibid.

22. S.R. Maheshwari, 'Administering Science and Technology for Development : A case study of India', in O.P. Dwivedi, ed., Perspectives on Technology and Development, (New Delhi, Gitanjali Publishing House, 1987), pp. 223-224.

> Science has developed at an ever-increasing pace since the beginning of the century,so that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward an utmost effort into the development of science that we can bridge that gap. It is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably man's greatest enterprise today.

The Resolution was both a testament of faith in science and a vision of society. It proclaimed a commitment "to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge." Its aim was not only to materially transform the life of our people but also to change the very outlook of our people and society. The Resolution had also aimed to provide a new strength to the scientific community and had provoked it to take up new responsibilities beyond its professional domains. It had urged the scientists to act as avant garde of a new instituional and renaissance of the country.[23]

Nehru's policy recognised the instrumental role of science in accomplishing industrialisation. The key to national prosperity lies in industrialisation which in turn

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23. A. Rahman, 'Science and Technology : Planning and Infrastructure, Link (New Delhi), 26 January, 1984, Special Issue, p. 21.

involves the combination of technology, raw materials and capital; technology assumes primary importance primarily because of its substitutive role in meeting the deficiencies encountered in respect of the other two factors, and technology can only grow out of the study of science and its application.[24]

The government in pursuance of the Science Policy Resolution, took steps to establish institutions for scientific and technical education and research, and endeavoured to create conditions which could generally promote science and technology and could result in implementation of new research achievements. Nehru wanted to associate scientists in the formulation of the plans. He was well aware that scientific research and its practical application had not been properly coordinated with plans of development and, therefore, he wanted the necessary coordination to develop between scientists, the government and the Planning Commission.[25]

Science Policy evolved as a result of interaction of the internal development of science and technology and the growing economic and political needs of the country. The

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24. Ibid.

25. Ibid.

role played by the political leadership was decisive in evolving science and technology policies, particularly in new and emergine areas. It required a farsighted and imaginative approach on the one hand, and long-term and heavy investment in research on the other. It was a result of this interaction that a major thrust was provided right at the beginning to such vital areas as atomic energy, electronics, space etc.[26]

The Resolution proposed to utilise science in import substitution which would lead to saving in the investment of capital, and through the development of science the gap between the advanced and backward would also be bridged.

5- The period after the mid-1960s has been marked by a tremendous thrust at the augmentation and reoreintation of the inherited science and technology system. Mrs. Gandhi's regime followed a policy of somewhat greater outward orientation in relation to the world, emphasising exports based on the new manufactures resulting from Nehru's industrialisation strategy; she also moved toward a more restrictive policy on both foreign investment and technology import whose hallmark became "selectivity".[27]

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26. Ibid.

27. B.R. Nayar, n. 2, p. 536.

The outward orientation for the economy through export promotion did not replace the earlier inward orientation (import-substitution) it only sought to supplement it.[28] However, the restrictive policy towards import of foreign technologies was adopted mainly in response to foreign exchange shortages. Controls were applied at several stages to access to foreign technology in the form of licensing agreements as well as direct foreign investments. The very first stage was to demarcate industries into three categories: those in which the government believed indigenous technology to be sufficient for the country's needs; those where some foreign technology was thought necessary but was not of a complex or tightly held nature for which so only licencing would be allowed; and those where both licensing and direct investment would be allowed.[29]

As India built her industrial and technological capabilities on the basis of foreign technology, it sought to become more restrictive and selective in regard to foreign investment and technology import. Foreign capital was now welcome only in such cases where access to

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28. Ibid., pp. 340-350.

29. Sanjay Lall, 'India's Technological Capacity', n. 18, p. 235.

technology could not otherwise be obtained. The new industrial policy in the 1970s declared that future development of industries must be based on indigenous technology as far as possible. At the same time it maintained that in order to promote technological self-reliance, the government recognised the necessity for continued inflow of technology in sophisticated and high priority areas where Indian skills and technolgoy were not adequately developed.[30] Though it may seem contradictory, it is important to distinguish between technological self-reliance as an ultimate and perhaps a distant goal and technology import in the interim as a necessary means to the achievement of that goal.[31]

An important factor that served to fortify the commitment to self-reliance was the involvement of India in several wars. More specifically in relation to technology import and technological dependence, the seriousness of the problem was first felt after the 1965 war when there was a ban on various kinds of imports of crucial materials and products as well as of certain crucial know-how. It was realised that technological dependence made for strategic

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30. B.R. Nayar, Vol. II, n.2, p. 393.

31. Ibid.

vulnerability and accordingly greater exphasis was placed on technological self-reliance.

The post-Nehru period represents a strong continuity with the earlier period in relation to science and technology policy. As a follow-up of the Scientific Policy Resolution of 1958, the government set up the National Committee on Science and Technology (NCST) in 1971. As considerable expansion had taken place in science and technology in India, it became necessary to relate it more closely with the process of planning and development. The first NCST thereafter prepared a science and technology plan (1974-1979), a pioneering and innovative venture in the Third World.

A point of special concern to Indira Gandhi had been the lack of linkage between science and industry. In order to rectify the situation, she sought to give greater coherence to the science and technology system (SAT) and make it functional for meeting the needs of economy and society. First, the laboratory network meant to serve industry was liberated from the control of the Ministry of Education and placed under the newly created Department of Science and Technology (DST) managed by scientists. The DST was to coordinate and promote the growth of science and technology

and their application for the development and security of the country.[32]

Secondly, the national leadership evolved a more explicit technological strategy, whose hallmark was a commitment to "technological self-reliance". Flowing from it, in an attempt to relate the existing SAT system as a potential source of technology to the expected demand for technology, primarily from the public sector, there was undertaken an effort as SAT planning whose basic component can be said to have been a broadfront "import-substitution" programme in the area of science and technology. This planning effort involved a significant involvement of the scientific community.[33]

Finally, through new policies, the government sought to link research and industry. In so far as the public sector was concerned, this was done through SAT planning. In relation to the private sector it was sought to be done through a structure of barriers and incentives, the intent of which was to persuade industry to utilise the existing research and development laboratory network as a source of technology, and especially, to undertake its own R & D. At

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32. Ibid., pp. 504-510.

33. Ibid.

the same time, the laboratories were instructed to go out and seek research contracts from industry.[34]

The continued emphasis on R & D did not simply mean an increase in expenditures on the existing research agencies; it also meant the creation of new agencies as new needs developed. Thus, to the earlier complex of specialised research organisations under Nehru there were added during Indira Gandhi's premiership the following research agencies: Department of Science and Technology; Department of Space and Department of Electronics.

The Department of Science and Technology formulates policies and sets out guidelines on science and technology. It sponsors scientific surveys and provide financial grants to national research institutions and scientific associations. It also looks after matters relating to the Council of Scientific and Industrial Research. The DST also has under it the National Research Development Corporation (NRDC) set up in 1953 to effect transfer to the industry the know-how developed in national laboratories and research institutes.[35]

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34. Ibid.

35. S.R. Maheshwari, n. 22, p. 277.

The Department of Space, set up in 1972, is responsible for development of an indigenous capability in aero-space engineering rockets and satellites, enhancing capability within the country for various applications of space technology to promote national development, and using the spin-off from development in space programmes in the fields of research, industry, education and related areas. A perspective of major space missions planned for the decade 1985-95 aims at interlocking the technological streams of the space effort for operational nation-wide applications in communications, resource surveys and meterology.[36] The Indian Space Research Organization (ISRO), under the overall guidance of Department of Space, is responsible for the planning, programming and managing R & D activities in space science, technology and applications.

The Department of Electronics established in 1970 is the executive wing of the Electronics Commission. The latter has been recently disbanded. The Department formulates policies and programmes for the development of electronics in the country. India has acquired the capability to produce a wide variety of electronic goods such as broadcasting equipment, telecommunication equipment, radars etc.

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36. Ibid., p. 227.

It was increasingly felt in the early eighties that the growth of technology should receive some kind of policy backing. While addressing the seventieth session of the Indian Science Congress at Tirupati on January 3,1983, Indira Gandhi announced the "Technology Policy Statement" of the government. The purpose of the statement was to give technological development a clear direction as regards the growth of indigenous technology and its acquisition from abroad. Explaining the purpose of the Technology Policy Statement, Indira Gandhi said, "The statement underlines the promise that for a country of our size and endowments, self-reliance is inescapable and that the use and development of technology must relate to the people's needs and aspirations. At the same time it is vital to take advantage of advances elsewhere to conserve our own time and resources as well as to aid the expansion and diversification of our technology".[37]

To keep abreast with the latest technology, the government under Rajiv Gandhi introduced the liberalisation of licensed capacity. In order to introduce latest technology with a view to give a further impetus to industry the scheme for re-endorsement of capacity was liberalised.

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37. Najmah Heptulla, India's Progress in Science and Technology (New Delhi, Oxford & IBH Publishing Co., 1986)., p.41.

An important policy measure taken under the present government is the appointment of Scientific Advisor to the Prime Minister. A Scientific Advisory Council to the Prime Minister was constituted in February 1986. The Council is mandated to advise the PM on (i) major issues facing science and technology today; (ii) the health of science and technology in the country and the direction in which it should move; and (iii) a perspective plan for A.D. 2001. The Council will also look at specific problems of different scientific departments as well as policies and priorities for research and technology missions.[38]

Two new departments have been set up in recognition of the growing importance of non-conventional energy sources (1982), and the future potential of bio-technology (1986). The government is also making efforts to strengthen the State Councils of Science and Technology, which were created during the Sixth Plan. A full-fledged Ministry of Science and Technology has been established. The Department of Science and Technology and a new Department of Scientific and Industrial Research (DSIR) form the two constituents of the Ministry. The Council of Scientific and Industrial

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38. Council of Scientific and Industrial Research, Status Report on Science and Technology in India : 1986, New Delhi., November 1986, pp. 2-3.

Research now comes under the purview of DSIR.[39]

To strengthen the country's scientific and technological base, the government has adopted a two-pronged strategy; (i) to enhance domestic technological capabilities in the strategic sectors of economy, such as energy, space, communications and national security, and (ii) to initiate research and development in frontier areas of science and technology in order to enable the country to play a significant role in the world technology market. Science and technology has an allocation of more than Rs. 2300 crores during the Seventh Five-Year Plan.[40]

With the recent establishment of the Telecommunications Commission, the government has drawn up a big plan for the expansion of the telecom network in the country during 1989-90. The mission under the chairmanship of Mr. Sam Pitroda, to modernise the country's telecommunication system, recently inaugurated the integrated measuring and surveillance system in New Delhi. This pilot project has been set up by a West German firm at a cost of Rs. 4, crores.[41] After the standardisation of the system achieved by the pilot project, the Telecommunication Research Centre

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39. Ibid.

40. Ibid., p. 5.

will extend to the entire network in the country.[41]

In retrospect it can be seen that the achievements in building a science and technology infrastructure have been substantial. With a fairly strong industrial base and a sound science and technology framework, India is now in a stronger position to adapt and assimilate latest technology for purposes of Defence and Development.

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41. Times of India, (New Delhi), 4 May, 1989.

CHAPTER THREE

TOWARD SELF-RELIANT DEFENCE

The security policy of India is broadly determined by the interplay of various political, economic and technological factors, at both the domestic and international levels. There is an underlying interdependence between security policy (foreign and military policies) on the one hand, and domestic economic policies on the other.[1] Economic policy has to accommodate a military programme to ensure the security of the nation. Indian military programmes have to be formulated according to the exigencies of the strategic environment. And the strategic environment,[2] in turn needs to be modified through appropriate foreign policy measures so as not to seriously damage Indian economic development.[3]

SECTION I

The security threats to India can be classified into three categories:[3] First, India's security anxieties arising from the world's two leading ideological systems,

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1. Raju C. Thomas, 'India', in Edward A. Kolodziej and Robert E. Harkavy, eds., Security Policies of Developing Countries, (Toronto, Lexington Books, 1982), p. 119.

2. Raju C. Thomas, Defence of India, (New Delhi, Macmillan, 1978), p.31.

3. O. Marwah, 'India's Military Power and Policy', in O. Marwah and J. Pollack, eds., Military Policy and Power in Asian States : China, India, Japan, (Boulder, Colarado, Westview Press, 1980), p. 102.

the socialist and the western liberal. In this regard, India deliberately chose to avoid direct participation in military alliances while simultaneously seeking to enlarge non-military interaction with both the liberal western and socialist blocs of states. But anxiety lingers that events beyond control, devolving from the cross-cutting global objectives and shifting strategic needs of the super powers, could lead to unexpected pressures on India. Examples of such possible ties include permanent super power naval deployment in the Indian Ocean with the consequent incentive to intervene in littoral state affairs; change and counter-change in US-Soviet relations with China; and unpredictable moves in major power arms transfer policies in relation to states within or bordering on South Asia.

Secondly, India's security needs which stem from the unresolved historical disputes over the extent of the Indian territory. The threats in these instances are external. They have also been specific in terms of location: from China in relation to adjustments over the northern boundaries, and from Pakistan in relation to the ownership of Kashmir. The nature and determination of the threats in these cases probably lie somewhere between the two extremes of either acceding fully to Chinese and Pakistani territorial claims or rejecting them completely.

Thirdly, India's most "permanent" security threats are generated by the conditions of poverty, inequity, lack of domestic cohesion, and the expectations raised by the very process of development and nation-building activity in which India will remain engaged for many decades. The threats in these instances are generic and internal. The nation's continuing poverty, its burgeoning population, and the fractiousness of its multi-ethnic community of peoples, make it vulnerable to internal turmoil and external pressures.

To the extent that the preceding categories of security problems reflect the need for military resolution, Indian leaders have made decisions providing the country with a broad spectrum of technological and economic capacities linked to the nation's defence.[4]

Given the resource constraints, Indian defence policy and planning required to be formulated in the context of the country's economic development programme. Although Indian perceptions of external threats to the nation may at times appear to call for a large-scale defense build up, domestic economic conditions may preclude such a policy.

For India, the basic defense-development dichotomy countinues to be this:[5] "external threats demand appropriate

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4. Ibid., p. 104.

5. Raju C. Thomas, n. 1., p. 119.

defense measures to meet or deter them, thus placing a strain on scarce economic resources; the urgency of economic development in India and the need for rapid social transformation demand that defense expenditures be maintained at a minimum, thereby increasing the security risk to the nation." This paradox is further aggravated by the fact that military prowess is dependent on economic and industrial development. A reduction in developmental expenditure in order to bolster the defence programme to meet immediate threats may, in fact, imply less defense potential in the future if such a diversion of resources retards economic growth.

There have been three phases of interpretation of the defence-development issue. First, the belief existed within the government of India, particularly in the years before the Sino-Indian war of 1962, that defence and development constituted competing claims to scarce economic resources. During the fifties it was felt that given a choice, the needs of development were paramount and therefore, foreign policy would have to be adjusted so as to require a minimum of defence spending.[6] Defence spending from 1947 to 1960 was low. Over this entire period the annual defence budget

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6. Raju C. Thomas, n. 2., p. 126.

averaged below 2 per cent of GNP. Economic growth by comparison was much higher at around 4.6 per cent. There was no aberration to this tend. Not even India's first war with Pakistan in 1948, nor China's invasion of Tibet in 1950 led to increases in defence expenditures by any appreciable degree. Exception was made in 1954-55 during which Pakistan entered the SEATO and CENTO defence pacts. The security relationship of Pakistan with the U.S. was potentially very destabilising as it serviced Pakistan's military with up to 2 billion worth of American arms.[7] A conscious effort was made to review and rearm the defence services. A favourable foreign exchange condition between 1945-57 and a general lack of experience in the domestic weapons production prompted the government of India to follow a policy of weapons purchases from abroad, mainly from Britain and France.

The second interpretation India placed on defence and development nexus came after the Sino-Indian conflict in 1962. The new military circumstances seemed to call for a reversal in the priorities of development and defence. Defence as a policy goal became significant because without it, the ability to secure the fruits of development could not be guaranteed. Consequently defence expenditure was

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7. Ron Matthews, Defence Production in India, (New Delhi ABC Publishing House, 1989), pp. 38-39.

increased. The annual budget for 1963-64 provided for a massive increase in defence expenditures over the previous year's allocation: Rs. 867 crores as against Rs. 473 crores spent in 1962-63.[8] For the first time India's military burden rose above 3 per cent of GNP; indeed, for that year, it reached almost 4 per cent. The changed policy and outlook, however, acknowledged the adverse effects of defence spending on the economy as well as the long-term dependence of defence on development. The available resources and effort that could be diverted to defense were, after all, dependent on the nation's industrial and technological progress. Consequently, diversion to defence was not to exceed a certain level where the long-term development programme would be jeopardized, which in turn might affect the absolute size of the defence programme itself.

In the immediate aftermath of the war India abandoned selectivity in the sources of its weapon supplies. Equipment came from sources as diverse as the U.S., the Soviet Union, Britain, West Germany, Canada and Yugoslavia.[9] The first Five-Year Defence Plan covering the period 1964-69

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8. Raju C. Thomas, n. 2, p. 106.

9. O. Marwah, n. 3, p. 111.

proposed a defence production base that would reduce the country's external dependence, as well as a modest expansion of defence research and development organisations. Beginning in 1964, Five-Year Defence Plans became rolling adjuncts of the country's five year economic development plans.[10]

The second Indo-Pakistan war of September 1965 provoked the National Development Council to authorize the Chairman of the Planning Commission to review the needs of both development and defence. Accordingly, a Planning Cell was established in November 1965 in the Ministry of Defence headed by an Additional Secretary to deal with the wider aspects of development planning. The new sytem was intended to facilitate short and long range defence planning and to maintain constant liaison with the Planning Commission and other ministries. In this manner it was expected that the defence effort would derive maximum advantage from the development effort by being able to place its priorities for consideration along with the overall economic and industrial plans being drawn up by the Planning Commission.[11]

The period following the Sino-Indian Conflict of 1962 and the Indo-Pak war of 1965 was characterised by a general

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10. Ibid., p. 112.

11. Raju C. Thomas, n. 2, p. 107.

Indian consensus that the specific threats to India came from China and Pakistan. The configuration of threats emanating from across the India-Pakistan and India-China frontiers, and the changing global alignments that aggravated or reduced the two-pronged threat, indicated the need to synchronise defence policies with domestic economic policy.

The final interpretation on the defence-development issue gained some popularity in the late sixties, especially in important sectors of the Defence Ministry and Armed Services Headquarters. It constituted a break from the traditional view on the economic consequences of defence spending. The new perspective suggested that defence spending added to the development effort by generating additonal demand and economic activity all around. Defence and Development were therefore considered complementary rather than competitive.[12] The emphasis on the civilian spin-off from defence spending carried three inter-related economic - political beliefs. "First, defence and development were not conflicting purposes but co-extensive and complementary objectives. Second, defence spending must reflect the nation's size and importance irrespective of the

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12. Ibid., p. 126.

prevailing threat; or at least it must be sufficient to assert India's independence from the great powers. Third, prestigious defence-oriented programmes may tend to uplift national morale, sustain political integrity, and in trun, generate economic confidence all round".[13]

By far the clearest statement of this line of reasoning came from K.Subrahmanyam, the then Director of the Institute for Defence Studies and Analysis. Subrahmanyam's views find support in a study by Professor Emile Benoit of Columbia University who concluded that there was a positive - rather than inverse - correlation between defence spending and economic growth in India, a finding that also seemed true of most developing nations.[14]

According to Benoit, in 1963 and 1964, the immediate years after the Sino-Indian war when Indian defence expenditures climbed to 4.5 per cent and 3.8 per cent of the GNP, the Indian Gross Domestic Product increased at an annual rate of 6.3 per cent per annum. This compared to a 4.5 per cent average economic growth rate in the period between 1950 and 1961 when defence received annual allotments of about 2 per cent of the GNP. Additionally,

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13. Ibid., pp. 128-129.

14. Ibid., p. 129.

Benoit's studies indicated that the sudden increase in defence expenditures after 1962 did not take place at the expense of investment. Investment relative to GNP over the period 1962-64 approximated to 16.5 per cent as against an average of 12.3 per cent for the period 1951-64.[15] However, over the long period, Benoit's findings could well be argued as spurious since the high growth rates could also be explained by high bilateral aid.[16] He argued that the 1962 war with China led to increased bilateral aid and increased military spending, which led to higher industrial growth rates as a result of demand stimulation and various modernising inducements. This was made possible by the import of American wheat which kept agricultural prices low.[17] However, this takes the story beyond Benoit's period which ended in 1965; the advantages of this growth were swamped by the rise in food prices, when the supply of American wheat dried up, and in oil prices and by the debt repayments on those foreign loans, which Benoit saw as the beneficial effect of the Sino-Indian war.[18]

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15. Ron Matthews, n. 7, p. 31.

16. Mary Kaldor, "The Military in Third World Development", in Mac Graham, Richard Jolly and Chris Smith, eds., Disarmament and World Development, (U.K., Pergamon Press, 1986), pp. 91-92.

17. Ibid.

18. Ibid.

After the 1.6 to 2 per cent band of defence expenditure/GNP experienced throughout the 1950s, the ratio never fell below 3 per cent. However, India's military burden increased during the tense two-year period between 1971-72, reaching almost four per cent. Moreover, after the 1971 military crisis, the government of India recognised that defence planning had to be integrated within the overall economic planning effort. By 1974 defense plans were made coterminus with development plans so that the needs and problems of both could be considered side by side.

Defence-development policies remain enigmatic. This is evidenced by the paradox that even though Defence plans became synchronised with the development planning from 1974-79 Fifth Development Plan onwards, defence, in the latter half of the 1980s, is still classified as 'non-Plan' expenditure in government budget accounts, inferring its 'non-impact' on development.[19]

However, the decision makers note that defense planning and production in India must have a minimum effect on development while also ensuring the maximum possible security for the nation. But this mini-max balance is a subjective and uncertain condition. A greater diversion to

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19. Ron Matthews, n. 7, p. 32.

defense need not necessarily increase the security of India. Similarly, less spending on defense may not produce a corresponding increase in the economic growth rate.[20]

What is striking about India's defence effort, despite the kind of security environment it has encountered, is its modest nature. It has been only in the latter part of 1980s that the burden broke through the 4 percent plateau. In 1987-88, defence expenditure reached approximately 5.5 per cent of GNP. The 1988-89 budget allocation for defence is Rs. 10,000 million more, at Rs. 1,30,000 million, than the previous year's budget figure.[21] It has been argued that India's defence procurment policies have been "reactive" to weapons inductions by adversary states.[22]

SECTION II

No free nation can afford to ignore the imperative need to maintain constant preparedness to defend any threat to its borders, much less in our case with our experience of past conflicts. This calls for a strong base of defence production coordinated with indigenous development.

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20. Raju C. Thomas, n. 1, p. 120.

21. International Defence Review Geneva, Switzerland, May 1988, p. 478.

22. B.R. Nayar, India's Quest for Technological Independence Vol. II, (New Delhi, Lancers Publishers, 1983), p. 484.

Modernisation of arms and a maximum degree of self-reliance in the shortest possible time have been the major objectives in our defence production effort.[23] The government of India sought to do this by the creation of indigenous military producjtion units and a research and development capability sufficiently broad and dynamic to produce current generation military equipment and serve as a catalyst to an advanced technology industrial sectors.

The Ordnance Factories, the Defence Public Sector Undertakings (DPSUs) and the Defence Research and Development Organisation (DRDO) are the important elements of the defence industry. The Ordnance sector and the DPSUs are organised under the Department of Defence Production within the Ministry of Defence, whereas the DRDO is a department in itself.[24]

There were sixteen Ordnance factories in India in 1947; today, there are thirty-six. These are divided into different groups, such as weapons, explosives, clothing and vehicles. The range of productive activities is wide, incorporating small arms and ammunition, explosives,

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23. Col. R. Rama Rao, Self-reliance and Security : Role of Defence Production, (New Delhi, Radiant Publishers, 1984), pp. 131-138.

24. Ron Matthews, n. 7, p. 55.

armoured vehicles, rocket propellants, parachutes and military apparel. The organisation is concerned with product development and effecient and effective implementation of projects, indigenisation and absorbing of new technologies of foreign designs under licenced production in critical areas. The value of gross production in 1987-88 was Rs. 1598 crores registering a growth of 17.6 per cent over the previous year.[25]

The Defence Public Sector Undertakings were established with a view to building up a strong and diversified production base capable of supplying technologically up-to-date weapons and equipment to the country's defence forces. The DPSU's involve themselves in the manufacture of modern, sophisticated weapons systems in advanced electronics; and in the production of exotic metal alloys for aerospace projects. Today, there are eight DPSUs listed in the following table:

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25. Ministry of Defence, Annual Report 1987-88, p. 30.

COMPANY	MAJOR ACTIVITES	MAIN LOCATIO
Hindustan Aeronautics Ltd. (HAL)	Aircraft, Aero-Engines, Avionics, Radar	Bangalore & Nasik.
Bharat Electronics Ltd. (BEL)	Radar, Electronics, Electro-Optics	Bangalore & Pune.
Bharat Earth Movers Ltd. (BEML)	Heavy Engineering Plant	Bangalore & Kolargold Fields.
Mazagon Dock Ltd.	Naval Vessel, Repair & Maintenance	Bombay
Goa Shipyard Ltd.(GSL)	- do -	Goa
Garden Reach Shipbuilders and Engineers Ltd. (GRSE)	- do - plus General Engineering	Calcutta
Bharat Dynamics Ltd.(BDL)	Naval ASW and Artillery Rockets, NST-58 Torpedo, Milan License Production	Hydrabad
Mishra-Dhatu Nigam Ltd. (Midhani)	Gun Barrel Forgings, Specialised Metals and Alloys for Weapons system and Aerosapace	Hydrabad

Source : International Defence Review (April 1986) p. 437

Note : ASW - Anti-Submarine Warfare.

Hindustan Aeronautics Limited (HAL)

The first DPSU, HAL is also the biggest. Production first began in 1940 to assist the Allied war effort in Asia. Although the main production complexes are at Bangalore and Nasik, there are further ten factories spread across the country. The twelve factories are located in six different states. The value of production, sales and profit (before

tax) during 1987-88 are provisionally estimated at Rs. 652 crores, 620 crores and 45 crores respectively.[26] Indigenisation programmes have been implemented by all the divisions of HAL as part of continuing efforts to achieve self-reliance. During the year 1987-88, sixty-six items have been indigenised. One of the major components indigenised was the floor board for use in the Cheetah helicopters. The anticipated foreign exchange saving due to these efforts is of the order of Rs. 268 lakhs per annum.[27]

Bharat Electronics Limited (BEL)

BEL was established by the Government in 1954 and was assigned the role of meeting the requirements of the Defence services and civilian government departments for professional electronic equipments and components for general use through indigenous production. It has grown to be the major electronics manufacturing organisation in the country today. The company presently has four operational units situated at Bangalore, Ghaziabad, Pune and Machilipatnam. Three more units are under various stages of completion at Panchkula (Haryana), Taloja (Maharashtra) and

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26. Ibid., p. 40.

27. Ibid.

Kotdwara (Garhwal, UP). Two establishments at Hyderabad and Madras are under implementation.[28]

Bharat Earth Movers Ltd. (BEML)

BEML was incorporated in 1964. It supplies 30 per cent of the coaches for the Indian Railways. From BEML's Kolar gold field's plant, heavy earth moving equipment is manufactured, also primarily intended for use in the civil sector. The equipment includes: dumpers, graders, scrapers and dozers, for use in vital core sectors like irrigation, power, coal, cement, steel plant and mines.

Mazagon Dock Limited (MDL)

MDL which was acquired by the government of India in 1960 is a leading ship-building and a ship-repair unit having facilities to manufacture sophisticated warships, submarines, missile boats and off-shore patrol vessels.[29]

Goa Shipyard Limited (GSL)

GSL was originally established in 1957 when Goa was still under Portuguese rule. The yard was taken over by the government of India in 1961. GSL is a subsidiary of MDL

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28. Ibid., p. 43.

29. Ibid., p. 46.

which holds 53.4 per cent shares of the company. The company's main activities are ship-building including warships, ships and barge repairs and associated general engineering works. During the last two decades the yard has been expanded to undertake the construction of a variety of sophisticated naval and other vessels.

Garden Reach Shipbuilders and Engineers Limited (GRSE)

GRSE too is engaged in maritime-related activities. There are seven plants in Calcutta with further two situated at Ranchi and Nagpur.

Bharat Dynamics Limited (BDL)

BDL, established in 1970s, is engaged in the production of guided missiles and other allied equipment systems. In 1982 the company completed production of the Aerospatiale SS-11-81, and is currently engaged in producing the MILAN[30]

Mishra Dhatu Nigam Limited (MIDHANI)

MIDHANI, established in 1973, manufactures a diverse range of special metals and super alloys in a wide variety of mill forms for several key industries in aeronautics, space, electronics, defence, atomic energy and chemical engineering sectors.

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30. Ron Matthews, n.7, p. 72.

Defence Research and Development Organisation (DRDO)

The realisation of the imperative need to change over to indigenous base to meet our defence requirements, led to the establishment of the DRDO in 1958. The DRDO operates through a complex network of over 45 inter-dependent laboratories and establishments located nationwide, and manned by over 3000 personnel. It is engaged in activities that include aeronautics, electronics, weapons systems, naval technology, engineering equipment, materials, life sciences, systems analysis, training and information.[31]

In her defense programme, India has followed a variant mix of three different policies.[32] (1) direct purchase of foreign equipment; (2) national production on the basis of indigenous research and development; and (3) licensing foreign technology for local manufacture. Though the first policy enables, quicker acquisition and induction of new weapon systems, it places a tremendous burden on foreign exchange resources. Furthermore, it enhances dependence on supplier states in times of crisis. The direct purchase of modern defence equipment from abroad was the dominant pattern during the 1950s. However, this policy was put to

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31. Ministry of Defence, Annual Report 1987-88, p.61.

32. B.R. Nayar, n. 22, pp. 486-493.

test when military aid was cut off to bring pressure on India during the Sino-Indian war of 1962 and the Indo-Pak war of 1965. This resulted in the shift of policy to domestic production of foreign weapons via cooperative ventures. India's subsequent attempts to develop domestic production capacity through acquisition of process technology received a setback from western nation's refusal to help. By contrast, the Soviets were far less reticent in supplying the techniques and skills required to manufacture its armaments. The classic example of this was when India was refused in the 1960s by the U.K. and the U.S. for the licensed manufacture of lightening fighter aircraft and F-104 Starfighter respectively. The Indian government turned to the Soviet Union and in August 1962 an argeement was struck to produce the MIG-21 in India. Thus the die was cast for close Indo-Soviet military - industrial cooperation. It was strengthened by the signing of the Indo-Soviet Treaty of Friendship and Cooperation in 1971. Progress was also facilitated by the concessionary nature of Soviet assistance. During the 1970s when foreign exchange was in short supply, India concluded deals with its Soviet partner whereby payment would be made in rupees with 2.5 per cent interest rates over 17 years, following a 7-year period of grace. This generosity continues in the 1980s. The MIG-27, for instance, is said to have been offered at about a

quarter the price that India paid for France's Mirage 2000, and both aircraft have comparable performances.[33]

The policy of reliance on local R & D, is ideally the best since it fits in with the commitment to self-reliance. But the goal of self-reliance that is undoubtedly the cornerstone of national policy must be evaluated in the light of the given realities of the resources constraint. Even whatever equipment is developed locally on the basis of the meagre defence R & D budget runs immediately into the serious problem of the armed services seeking weapons that are not simply good but comparable to those possessed by adversaries.

In between the two policies of direct purchase and of production on the basis of local R & D is the third policy of relying on licensing for local production. This policy enables the country to cut down on the time necessary for the production of equipment. Moreover, it makes possible the establishment of a technological base at a fairly high level to be used for further local R & D. Although it still suffers from the drawback of the first policy in terms of dependence, it holds the possibility of breaking away from

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33. K.K. Subrahmanyam, 'Rethinking on Domestic Manufacture', The Financial Times (London), 11 June, 1984.

it over the long run.[34]

It has been largely manufacture based on licensing of foreign technology that has played the major role in meeting the needs of India's armed forces for the large and sophisticated equipment. Many of the advanced weapons systems included in India's military inventory have been procured from abroad. Specifically, the major foreign systems procured over recent times cover: Sea King helicopters (UK) ; Sea Harrier fighters (UK); Jaguar aircraft (UK/Fr.); Mirage 2000 fighters (Fr.); MIG-21 Bi, MIG-23 and MIG-29 fighters (USSR); Kresta III type cruisers (USSR); Kashin class destroyers (USSR); Petya class frigates (USSR); Nanuchka class corvettes (USSR); aircraft carriers (Vikrant and Vikraat) (U.K.); Polnocry landing craft (Pol.), 200t, inshore patrol vessels (Singapore); Foxtrot-class (USSR), Kilo-class (USSR), and Type-1500 (FRG) submarines plus 1 'Charlie' class nuclear propelled submarine under lease (USSR); T-72 tanks (USSR); Bofors 155 mm field guns, and anti-tank equipment (Sweden).[35]

For any country, let alone one that is classified as belonging to the third world, this array of modern weaponry is awesome. But the impressive list of imported military

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34. B.R. Nayar, n. 22, p. 487.

35. Ron Matthews, n. 22, p. 487.

equipment should not be allowed to obscure the progress achieved in domestic defence production. Through a deliberate policy of encouraging licensed production India has reached the threshold of full indigenisation - a difficult task to accomplish !

A major plank of India's defence production policy has been indigenisation. The 1978-79 annual report published by the Ministry of Defence made this explicit when it stated "Rapid indigenisation is the cornerstone of our policy of self-reliance". But two conditons require to be met if the drive for indigenisation is to be successful.[36]

First, co-production of defence equipment with foreign suppliers must involve the transfer of production know-how and techniques along with the product itself. India has shown its discretion in this respect, and over the last three decades has negotiated the transfer of production facilities and foreign expertise from numerous sources. In fact, by the late seventies, India's bargaining position had enhanced due to the increased industrial and technical capabilities. Thus the 1978 choice of co-producing the Anglo-French Jaguar was based not so much on price but rather on considerations relating to the scope and speed of

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36. Ibid., p. 95.

the transfer of the aircrafts technology. The technical transfer aspect of contractual arrangements became institutionalised within collaborative agreements. It was a two-pronged approach[37]: foreign purchase would be made only if design and development work. By contrast, the DPSUs, which have substantial R & D capability, cooperate with DRDO establishments when seeking technical improvements to systems and techniques. "India's defence R & D budget has not yet matched the DRDO's vast organisational structure. In the 1960s it hovered around one per cent of the defence budget, rising to 2 per cent only by 1975-76. Today, however, it is over 8 per cent - a reflection of the important indigenous defence projects currently being undertaken".[38]

Indigenisation involves overcoming numerous development and technological obstacles. The 1985-86 Annual Report cited three constraints affecting indigenisation of defence equipment:

- non-availability of specifications and drawings from military equipment collaborators for many of the items supplied. The designs thus have to be evolved by reverse engineering techniques and proved by extensive proto-type trials;

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37. Ibid., pp. 95-97.

38. Times of India (New Delhi), 14 April, 1987.

- the prescription of rigid quality standard; and
- uncertainty regarding continutity of orders due to rapid obsolescence and fluctuations in demand.

These factors have contributed to the problem of delays in forcing indigenous equipment development through to the production stage. "Some observers judge the major fault to lie with the lack of production and quality - foreign suppliers agreed to firstly transfer manufacturing technology, and secondly to incorporate "buy-back" clauses in sales contracts. The intended aim was to achieve self-sufficiency through indigenisation, while, at the same time, earning scarce foreign exchange, selling weapon systems components back to the defence technology transferor".[39]

The second condition for successful indigenisation concerns the establishment of a local science and technology base to accommodate the transfer of learning from collaborative defence programmes. India recognised this need early. In 1958 the Defence Research and Development Organisation was established for the purpose.

But the limited capacity of in-house research and development and the lack of sufficient trained manpower for specialised R & D work for the army, air force, and navy,

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39. Ron Matthews, n. 7, p. 97.

often results in gaps between initiation of design work and actual production is painfully long, and the resultant weapons are obsolete even before they are deployed.[40] The evolution of the Arjun Main Battle Tank (originally called Chetak) has been under development for a decade. Delays in the tank reaching production stage resulted in the inability to locally develop an effective diesel engine. Prototype MBTs have therefore had to be fitted with imported power plants. The aerospace sector has similarly been affected. The failure to indigenously develop the HF-24 Marut fighter has again been due to India's aeronautical engineers having been working on a successor fighter aircraft. Preparatory work on a Lightweight Combat Aircraft (LCA) incorporating fly-by-wire technology and composite materials was begun in 1980. The project is being executed jointly by DRDO, HAL, CSIR and several universities. The work of these bodies is coordinated under a single umbrella organisation called the Aeronautics Development Agency (ADA). The object of the research programme is to indigenously develop a low-cost agile combat aircraft to out-perform Pakistan's F-16 fighter. An approved outlay of Rs. 600 crore has been allocated to prototype development. However, design and development difficulties with the LCA's GTX engine are being

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40. B.R. Nayar, n. 22, p. 487.

encountered. Now the prototype aircraft will be powered by the US General Electric F-404 engine. Dassault of France is assisting with project definition work and the US Airforce Wright Aeronautics Laboratory has been contracted to work on advanced technologies for materials, components and systems.[41]

To date, successful indigenisation of major weapon systems has been limited. Development of the Ajeet Fighter plane, an advanced version of the license - produced Gnat aircraft from Britain perhaps comes closest.[42] Under the Integrated Guided Missile Development Programme the first ever flight test of Prithvi missile, a surface to surface tactical battlefieled missile system, was conducted successfully in February 1988. With the success of the Prithvi system, a totally indigenous effort, India joins the select group of four nations which have developed this class of missile.[43] The 7.62 mm Ishapore Rifle and the 105 mm and 120 mm field guns are both good examples of Indian development expertise further down the technological scale of weapons design. But it should be emphasised that the ability to innovate whether in the civil or defence

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41. The Times (London) 16 October, 1987.

42. Ron Matthews, n.7, p. 101.

43. Ministry of Defence, Annual Report 1987-88, p. 65.

industrial areas is the ultimate, and therefore the most difficult, attribute of industrialisation developing countries can secure. It is basically "a cumulative process of learning and experience, of making mistakes and taking risks, which is intially quite costly and perhaps unproductive, but which must be undertaken seriously,"[44] if developing countries like India are to achieve complete indigenisation.

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44. Ron Matthews, **n**.7, p. 102.

CHAPTER FOUR

CONCLUSION

The purpose here is not to make judgements on the opportunity cost of defence expenditure. Where there is a trade off between economic growth and defence investment, it remains contentious, even after two decades of intense debate. Various economists in the world have leaned either towards the positive or negative effects of defence spending on development. The actual effects have varied depending on the peculiarities of local economic conditions, economic policies, technological constraints, and attitudes of populations to save and invest under various security threats and internal political conditions. There can therefore be no objective answer to the question of whether defence spending retards or stimulates economic development.

The defence-development issue assumes significant importance because India is still in the process of development. Scarce resources seem to compete for both defence and development. Moreover, the process of development unleashes destablishing forces in the form of "revolutions of rising expectations"[1] which not only retards the process of development but also make the country more vulnerable to external threats. Both defence and

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1. Bruce E. Arlinghaus, 'Social versus Military Development : Positive and Normative Dimensions', in James Everett Katz, ed., Arms Production in Developing Countries, (Toronto, Lexington Books, 1984), p. 41.

development are essential in the enhancement of national security-neither can be ignored at the cost of the other. Indian decision-makers have to show creativity in deciding to what extent Indian defence spending may be pushed without adversely affecting development.

Science and technology play a very vital role in enhancing defence and accelerating the development process. But it must be remembered that science and technology alone can make little contribution without the will of the nation to advance economically, and the opportunity and organisation to use them.

The possibility and desirability of developing countries using science and technology, particularly highly sophisticated and "advanced" science-based technology, to "leap-frog" a few socio-economic 'stages' through which the industrialised countries of today passed in the course of the last 300 years, needs to be re-assessed. By this, one is not ruling out the possibility of developing countries adopting technological solutions to their problems, derived from the 20th century and especially post-1950 science, and different from those which the highly industrialised countries used. Indeed it is this possibility which forms the linch pin of much of the excitement of "science and

technology for development" today. But if such different technologies are to be used in conjunction with economic and social policies of a 'traditional' kind, to bring about development styles which are imitative of those of the highly industrialised countries of today, then we would be falling into a dangerous trap, our 'most powerful' technologies not withstanding.[2]

The mere availability of science and technology, however, does not automatically ensure economic development. If science and technology are to contribute to productive processes, the country needs quality scientists and technologists who are able to identify the main areas of national importance. At the same time, effective coordination should be established between the relevant government departments, research laboratories and industrial enterprises in order to get adequate dividends from the nation's investment in science and technology.

The battles of today and tomorrow will be veritable clashes of technologies; while national resources and human

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2. Ashok Parthasarathi, "Science and Technology in our search for a sustainable and just future", unpublished paper at a Seminar on Nation-Building, Development Process and Communication : A national Seminar in Search of India's Renaissance, held at Vigyan Bhawan, New Delhi on 3-7 December, 1988, pp. 10-11.

skill will circumscribe the fighting potential of our armed forces, the crucial factor will be increasingly the technological base for the wherewithal at their disposal.

In such a scenario, our great asset is the solid base provided by the founding fathers of independent India, who had the vision to establish a chain of national research laboratories. In our scientists, engineers and academicians, we also have a vast reservoir of human ingenuity and a virtual brains trust. Years ago, we also established a number of defence research laboratories which today provide the infrastructure for the march towards self-reliance.

With this vast potential for self-reliance we do have a string of achievements to our credit that we can be justifiably proud of. Yet it is a paradox that in many vital fields we still remain import-oriented. Perhaps this was unavoidable, given the background of our development and varied demands on our limited resources.

The clear and continuously articulated goal of the Indian planning authorities in the area of industrial activity, as inevitably in most others, has centred on the 'urgent' need to indigenise defence production and to become self-reliant as far as possible in military technology.

India's defence expenditure has been on the rise since 1981-82. While the annual growth in absolute terms was around 15 per cent, in real terms the growth remained around six per cent initially. The budget for 1986-87 showed a significant growth in defence expenditure - up from Rs. 7,988 (actuals) crores in 1985-86 to Rs. 10,194 crores for 1986-87, registering a slighly more than 27 per cent growth. The 1987-88 budget estimates indicated a further 23 per cent increase to Rs. 12,512 crores. Very little perhaps can be done to curtail the rate of growth of the defence expenditure without seriously eroding the combat effectiveness of the armed forces. Cutting on modernisation can be highly counter-productive. Yet it is highly debatable whether the nation can really bear the cost of defence at the rate at which it is growing. It is obvious that serious thought will have to be given to keeping the burden of defence within manageable and affordable limits. Indigenous development and production of defence equipment is of great help. The growth in the Defence Research and Development (R & D) budget from Rs. 95 crores in 1981-82 (2.19% of the total) to Rs. 464.86 crores in 1987-88 (3.87%) and Rs. 561.60 crores in 1988-89 (4.32%) is a very healthy sign in this regard.[3]

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3. Hindu (Madras), 5 March, 1988.

Three important aspects will have to be given serious consideration in the coming years : maintaining a rapid growth in R & D resources, willingness to take risks and learning from failures, and rapid acquisition of military technology from all possible sources. Efforts will also be required to turn to account lateral spin-offs of civil and defence R & D.

An area which requires urgent attention is arms exports to ease the burden of defence to the maximum extent possible. Defence Minister K.C. Pant's announcement that the government is planning to export defence equipment marks a departure. India has so far followed a deliberate policy of not exporting arms. One of the major arguments used against export of arms is that it will go against our foreign policy objectives geared to non-alignment. This is a fallacy. To export arms (or to import them), it is not necessary to be part of an alliance system. While arms exports will certainly add another dimension to foreign policy management, export of arms and military technology is an important tool of foreign policy in today's world.[4]

Ruling out exports means that the production runs are automatically restricted to domestic needs. This is not

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4. Times of India (New Delhi), 13 February, 1989.

only the more costly option, but it has a retarding influence on the scale and scope of indigenous research, design and development. At the same time, the momentum of technology imposes its own tyranny in terms of the quality and costs of the new weapons. In actual terms, the technological imperative has been the single largest factor responsible for our defence budget increasing from Rs. 3,867 crores in 1980-81 to Rs. 13,000 crores in 1988-89.

The qualitative level of defence output is remarkable. From an advanced aerospace and electronics industrial springboard India is currently undertaking project work in missile technology; VSTOL (HF-73) multi-role combat aircraft; Supersonic remotely piloted vehicles, with technology similar to that employed in cruise missiles; and conversion of the HS-748 (AVRO) aircraft to an AWAC-type plane. These examples illustrate the development work in sophisticated areas of technology.[5]

But caution needs to be exercised in assessing India's performance in achieving self-sufficiency in weapons technology. The country is certainly actively involved in producing a diversified panoply of military equipment.

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5. Ron Matthews, Defence Production in India, (New Delhi, ABC Publishing House, 1989), p. 113.

Overall, India has not really been successful, in evolving manufacturing expertise in all areas of weapons technology. Many of the key components in advanced, and even more basic, defence equipment still have to be procured from foreign suppliers. Experience has shown that progress in this area will not be easily achieved. There is the further obstacle that successful indigenisation works against the interests of the foreign arms supplier. It has been reported, for instance, that the Soviet Union made access to some of its systems, in the T-72 tank conditional on India putting a Soviet engine in the new battle tank.[6] Moreover, if the defence industrial base lacks the ability to press forward in research and development work and successfully innovate, then indigenisation becomes rather a static concept. The problems India has experienced in the past have centred on its ability to transcend this threshold. Technology innovation does not begin or end with the acquistion of technology. It encompasses the set of activities that brings a potential new element of technology from conceptualisation into actual use. If technology is to be imported, there are questions of its appropriateness, the terms of license, and most important of all, the degree of adaptation needed for it to conform the factor endowments of the country that has imported it. Following acquisition

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6. Ibid., p. 114.

come the stages of adaptation, engineering, manufacturing design and market development.[7]

Moreover, "institutionalising innovational endeavour through public sector research bodies has not been very effective, because it fails to tackle the fundamental problem: the absence of entrepreneurial motivation."[8]

There have recently been signs that the government is prepared to improve innovational performance. Policies have been enacted over recent years to liberalise the economy; to reduce government interference in industry. Greater civil involvement in specifically defence production is now being officially recommended. For examples, it was announced that the domestically designed Arjun MBT would be powered by a diesel engine, provided indigenously by the private sector firm, Kirloskars. Moreover, nearly 50 per cent of the systems and sub-systems involved in the production of the Soviet designed T-72 battle tanks and infantry combat vehicles have been identified for indigenous manufacture in the private sector.[9]

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7. F.A. Long, "Science and Technology in India : Their Role in National Development" in John W. Mellor, ed., India-A Rising Middle Power, (New Delhi, Select Book Service Syndicate, 1981), pp. 240-41.

8. Ron Matthews, n. 5, p. 115.

9. Ibid., p. 89.

India's achievements in the nuclear and space fields shows the cumulative levels of technological expertise absorbed by the economy over the last two decades. Although India's pursuit of indigenisation in specifically defence production has encountered many setbacks, the progress made in the Nuclear and Space programmes stand out.

The country's declared aim is to utilise nuclear energy for peaceful purposes. Capabilities have been created over the entire gamut of nuclear cycles right from exploration and mining of atomic minerals, preparation of high purity nuclear materials such as Uranium, Thorium, Plutonium, Zirconium, production of fuel elements for reactors, designing and construction of power reactors and their control systems, production of heavy water, health and safety instrumentation to reprocessing of spent fuel and waste management. The attempt has been to achieve self - reliance and to reduce vulnerabilities in this strategic area. Four nuclear power stations have been established at Tarapur, Narora, Kalpakkam and Kota. These stations have been set up with indigenous efforts. The Tarapur nuclear power station was built under a turn-key project by the U.S. The Rajasthan nuclear power station involved a measure of Indian indigenous effort in collaboration with Canada. The Kalpakkam station was built entirely through indigenous effort. The Narora nuclear power station, again based on

indigenous effort is nearing completion. Considerable advances have been made in the use of nuclear energy in medicine, agriculture and other areas. India has been successful in creating a self-contained and autonomous, scientific programme and community in the nuclear field.

Whilst efforts were being made to develop the nuclear programme, parallel development was taking place in space ventures designed for telecommunications purposes. Rapid progress has been made in the space technology programme. The first big step was taken in 1963 with the launch of a two - stage Nike Apache Sounding Rocket from the Thumba Equatorial Rocket Launching Station. In 1972, India with Soviet assistance designed and manufactured a scientific satellite, launched from a Soviet launch vehicle in the USSR. India's first satellites, the Bhaskara I and II missions were launched in 1979 and 1981. These were both concerned with photographic reconnaissance encompassing the scientific fields of hydrology and geology. In the 1980s the Indian National Satellite (INSAT) was introduced, extending the country's capabilities into telecommunications, meteorology and television services.[10] The progress in nuclear and space endeavour places India in an exclusive international club. It signifies not only technological excellence but also an elevated diplomatic status.

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10. Ron Matthews, n.5, pp. 106-107.

APPENDICES

APPENDIX I

GOVERNMENT OF INDIA

Scientific Policy Resolution

New Delhi, the 4th March, 1958

No.131/CF/57. - The key to national prosperity, apart from the spirit of the people, lies, in the modern age in the effective combination of three factors, technology, raw materials and capital, of which the first, is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for a deficiency in natural resources, and reduce the demands on capital. But technology can only grow out of the study of science and its applications.

2. The dominating feature of the contemporary world is the intense cultivation of science on a large scale, and its application to meet a country's requirements. It is this, which, for the first time in man's history, has given to the common man in countries advanced in science, a standard of living and social and cultural amenities, which were once confined to a very small privileged minority of the population. Science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically

altered man's material environment, but, what is of still deeper significance it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism.

3. It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of a recognition of this possibility that the idea of a welfare state has grown. It is characteristic of the present world that the progress towards the practical realisation of a welfare state differs widely from country to country in direct relation to the extent of industrialisation and the effort and resources applied in the pursuit of science.

4. The wealth and prosperity of a nation depend on the effective utilisation of its human and material resources through industrialisation. The use of human material for industrialisation demands its education in science and training in technical skills. Industry opens up possibilities of greater fulfilment for the individual. India's enormous resources of man-power

can only become an asset in the modern world when trained and educated.

5. Science and technology can make up for deficiencies in raw materials by providing substitutes, or, indeed, by providing skills which can be exported in return for raw materials. In industrialising a country, a heavy price has to be paid in importing science and technology in the form of plant and machinery, highly paid personnel and technical consultants. An early and large scale development of science and technology in the country could therefore greatly reduce the drain on capital during the early and critical stages of industrialisation.

6. Science has developed at an ever-increasing pace since the beginning of the century, so that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward our utmost effort into the development of science that we can bridge the gap. It is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today.

7. The Government of India have accordingly decided that the aims of their scientific policy will be -

i) to foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects - pure, applied, and educational;

ii) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation.

iii) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific acitivity;

v) To encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom;

vi) and, in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Government of India have decided to pursue and accomplish these aims by offering good conditions of service to scientists and according them an honoured position, by associating scientists with the formulation of policies, and by taking such other measures as may be deemed necessary from time to time.

APPENDIX II

GOVERNMENT OF INDIA

Technology Policy Statement

Preamble

Political freedom must lead to economic independence and the alleviation of the burden of poverty. We have regarded science and technology as the basis of economic progress. As a result of three decades of planning, and the Scientific Policy Resolution of 1958, we now have a strong agricultural and industrial base and a scientific manpower impressive in quality, numbers and range of skills. Given clear-cut objectives and the necessary support, our science has shown its capacity to solve problems.

The frontiers of knowledge are being extended at incredible speed, opening up wholly new areas and introducing new concepts. Technological advances are influencing life-styles as well as societal expectations.

The use and development of technology must relate to the people's aspirations. Our own immediate needs in India are the attainment of technological self-reliance, a swift and tangible improvement in the conditions of the weakest sections of the population and the speedy development of backward regions. India is known for its diversity.

Technology must suit local needs and to make an impact on the lives of ordinary citizens, must give constant thought to even small improvements which could make better and more cost-effective use of existing materials and methods of work. Our development must, be based on our own culture and personality. Our future depends on our ability to resist the imposition of technology which is obsolete or unrelated to our specific requirements and of policies which tie us to systems which serve the purposes of others rather than our own, and on our success in dealing with vested interests in our organizations: governmental, economic, social and even intellectual, which bind us to outmoded systems and institutions.

Technology must be viewed in the broadest sense, covering the agricultural and the services sectors along with the obvious manufacturing sector. The latter stretches over a wide spectrum ranging from village, small-scale and cottage industries (often based on traditional skills) to medium, heavy and sophisticated industries. Our philosophy of a mixed economy involves the operation of the private, public and joint sectors, including those with foreign equity participation.

Our directives must clearly define systems for the choice of technology, taking into account economic, social and cultural factors along with technical considerations; indigenous development and support to technology, and utilization of such technology; acquisition of technology through import and its subsequent absorption, adaptation and upgradation; ensuring competitiveness at international levels in all necessary areas; and establishing links between the various elements concerned with generation of technology, its transformation into economically utilizable form, the sector responsible for production (which is the user of such technology), financial institutions concerned with the resources needed for these activities, and the promotional and regulating arms of the Government.

This Technology Policy Statement is in response to the need for guidelines to cover this wide-ranging and complex set of interrelated areas. Keeping in mind the capital-scarce character of a developing economy it aims at ensuring that our available natural endowments, especially human resources, are optimally utilized for a continuing increase in the well-being of all sections of our people.

We seek technological advancement not for prestige or aggrandisement but to solve our multifarious problems and to be able to safeguard our independence and our unity. Our

modernization, far from diminishing the enormous diversity of our regional traditions should help to enrich them and to make the ancient wisdom of our nation more meaningful to our people.

Our task is gigantic and calls for close co-ordination between the different departments of the Central and State Governments and also of those concerned, at all levels, with any sector of economic, scientific or technological activity, and, not least, the understanding and involvement of the entire Indian people. We look particularly to young people to bring a scientific attitude of mind to bear on all our problems.

2. Aims And objectives

2.1 Aims

The basic objectives of the Technology Policy will be the development of indigenous technology and efficient absorption and adaptation of imported technology appropriate to national priorities and resources. Its aims are to :

a] attain technological competence and self-reliance, to reduce vulnerability, particularly in strategic and critical areas, making the maximum use of indigenous resources;

b] provide the maximum gainful and satisfying employment to all strata of society, with emphasis on the employment of women and weaker sections of society;

c] use traditional skills and capabilities, making them commercially competitive;

d] ensure the correct mix between mass production technologies and production by the masses;

e] ensure maximum development with minimum capital outlay;

f] identify, obsolescence of technology in use and arrange for modernization of both equipment and technology;

g] develop technologies which are internationally competitive, particularly those with export potential;

h] improve production speedily through greater efficiency and fuller utilization of existing capabilities and enhance the quality and reliability of performance and output;

i] reduce demands on energy, particularly energy from non-renewable sources;

j] ensure harmony with the environment, preserve the ecological balance and improve the quality of the habitat; and

k] recycle waste material and make full utilization of by-products.

2.2 Self-Reliance

In a country of India's size and endowements, self-reliance is in-escapable and must be at the very heart of technological development. We must aim at major technological break-through in the shortest possible time for the development of indigenous technology appropriate to national priorities and resources. For this, the role of different agencies will be identified, responsibilities assigned and the necessary linkages established.

2.3 Strengthening the Technology Base

Research and Development, together with science and technology education and training of a high order, will be accorded pride of place. The base of science and technology consists of trained and skilled manpower at various levels, covering a wide range of disciplines, and an appropriate institutional, legal and fiscal infrastructure. Consolidation of the existing scientific base and selective strengthening of thrust areas in it are essential. Special attention will be given to the promotion and strengthening of the technology base in newly emerging and frontier areas such as information and materials sciences, electronics and

bio-technology. Education and training to upgrade skills are also of utmost importance. Basic research and the building of centres of excellence will be encouraged.

Skills and skilled workers will be accorded special recognition. The quality and efficiency of the technology generation and delivery systems will be continuously monitored and upgraded. All of this calls for substantial financial investments and also strengthening of the linkages between various sectors (educational institutions, R & D establishments, industry and governmental machinery).

3. Priorities

3.1 Need for Perspective Planning

The time scales involved in the generation of technology are long, even with imported elements. Therefore, relevant technologies in all areas of priority, particularly where large investments are to be made, should be clearly identified well in advance. The cost and time element involved in the import of technology and indigenous development will be given consideration. Components which could be assigned to the various institutions which are capable of developing them or which could be built up for such activities will be identified. Ministries concerned with large investments and production activities in areas

such as food, health and energy will be provided with appropriate technical support through suitably structured S & T groups.

3.2 Employment

Human resources constitute our richest endowment. Conditions will be created for the fullest expression and utilization of scientific talent. Measures will be taken for the identification and diffusion of technologies that can progressively reduce the incidence of poverty and unemployment, and of regional inequalities. The application of science and technology for the improvement of standards of living of those engaged in traditional activities will be promoted, particularly household technologies. Technologies relevant to the cottage, village and small industries sector will be upgraded. In the decentralized sector labour must be diversified and all steps taken to reduce drudgery. In all sectors, the potential impact on employment will be an important criterion in the choice of technology.

3.3 Energy

Energy constitutes an expensiive and sometimes scarce input. Therefore, the energy requirements both of a direct and indirect nature for each product and each production activity and the associated technology employed will be

analysed. Measures will be devised to avoid wastage or non-optimal use of energy. Fiscal measures as necessary will be introduced to ensure these. Research and Development in the energy sector will aim at improving the efficiency of its production, distribution and utilization, as well as improvement of efficiency in processes and equipment.

3.4 Efficiency and Productivity

Technologies already employed will be evaluated on a continuing basis to realise maximum benefits in terms of increased production and lower costs, specially in the public sector enterprises. Every effort should be made to utilise by-products and wherever possible to recycle waste materials, especially those from urban areas. Programmes to make use of the easily available and less costly materials will be supported.

3.5 Environment

Development should not upset the ecological balance for short as well as long-term considerations. Poorly planned efforts to achieve apparently rapid development, ignoring the long-term effect of many technologies on the enviornment, have resulted in serious ecological damage. It is, therefore, esential to analyse the environmental impact of the application of each technology. Due regard will be

given to the preservation and enhancement of the enviornment in the choice of technologies. Measures to improve enviornmental hygiene will be evolved.

3.6 Some Specific Areas

In technology development special emphasis will be focused on food, health, housing, energy and industry. In particular, stress will be laid on:

- agriculture including dry-land farming;
- optimum use of water resources, increased production of pulses and oilseeds;
- provision of drinking water in rural areas, improvement of nutrition, rapid reduction in the incidence of blindness, eradication of the major communicable diseases (such as leprosy and tuberculosis), and population stabilization;
- low-cost housing;
- development and use of renewable non-conventional sources of energy; and
- industrial development

4. Indigenous Technology

4.1 Importance of Technology Development

Fullest support will be given to the development of indigenous technology to achieve technological self-reliance and reduce the dependence on foreign inputs, particularly in critical and vulnerable areas and in high value-added items in which the domestic base is strong. Strengthening and diversifying the domestic technology base are necessary to reduce imports and to expand exports for which international competitiveness must be ensured.

4.2 Inventions

The spirit of innovation and invention is the driving force behind all technological change. We must awaken our science and technology to the exciting challenges of our times, provide incentives to encourage inventors, and direct their efforts to areas of special importance. The system of rewards and incentives will be strengthened for inventions, innovations and technological breakthroughs and their utilization. The fullest opportunity will be provided to make use of inventions.

4.3 Enhancing Traditional Skills and Capabilities

Traditional skills and capabilities will need to be upgraded and enhanced, using knowledge and techniques generated by advances in science and technology. Technologies which will result in low-cost production and in products marketable close to the point of manufacture, particularly in the rural sector, will be promoted. Support will be given to technologies which reduce pressure on items in short supply and utilize improved local materials and methods. Government will give preference to products of such technologies in its own purchases. The adoption of technologies that can promote decentralized production will be helped through the support to design, marketing, quality control and other services.

4.4 Ensuring Timely Availability

The time cycle from scientific research to utilization is a long one. Hence the need to initiate action well in advance to identify and ensure timely availability and delivery of new technologies. Encouragement and support (fiscal, commercial and administrative) will be given to the production and user organizations to be assocated with and participate in technology development efforts at appropriate stages.

4.5 Upgradation to Prevent Obsolescence

Technology is constantly on the move. The base of indigenous technology should be capable of utilizing world-wide advances and adapting them to local needs. The creation and strengthening of institutional structures for keeping track of international developments will receive urgent attention.

A strong central group will be constituted to undertake technology forecast and technology assessment studies and will inter alia draw up programmes of purposeful research. Arrangements will be made to provide high-level scientific advice in major sectors of the economy. Where big investments are involved or a large volume of production is envisaged, it will be incumbent on the Ministry or agency concerned to provide a technology forecast covering its requirements over a ten-year or longer period and evolve a strategy for development based on priorities.

4.6 Increasing the Demand for Indigenous Technology

Our country has already invested significant amounts in setting up research and development facilities as well as design consultancy and engineering capabilities. The technological potential inherent in this system of interlinked capabilities must be fully utilized, and in turn

provide a fillip for further development from within the system. Incentives will, therefore, be provided to users of indigenously developed technology, and for products and processes resulting for such use.

4.7 Preferential Treatment

In view of the cost of technology development and the time necessary for successful marketing of a new or improved product, indigenously developed items are invariably at a disadvantage compared with imported products or those based on imported technologies and brand names. Support must therefore be provided through fiscal and other measures, for a limited period, in favour of products made through indigenously developed technologies, care being taken to ensure quality.

4.8 Fiscal Incentives

Suitable financial mechanisms will be established to facilitate investment on pilot plants, process demonstration units and prototype development in order to enable rapid commercial exploitation of technologies developed in laboratories. Linkages between scientific and technological institutions and development banks will be strengthened. Gaps in technology will be identified and suitable corrective measures taken with adequate allocation of

resources. Fiscal incentives will be provided in particular to promote inventions; increase the use of indigenously developed technology; enhance in-house Research and Development in industry; and efforts directed to absorb and adapt imported technology.

4.9 Design Engineering

Capabilities in design engineering are essential for the translation of know-how to commercial production. This is particularly important in areas relating to agricultural production; agro-industries; metallurgical, chemical and petrochemical processes; machine tools; industrial machinery and capital goods as well as for the construction and erection of entire plants. Building up and enhancing these capabilities will have a catalytic beneficial impact on the utilization of indigenous efforts that have resulted in product and process know-how. Existing design engineering capabilities will be strengthened and upgraded, and interaction encouraged between design engineering organizations, academic and research institutions and industry. Wherever gaps exist, design engineering capabilities will be developed and nurtured.

4.10 Engineering Consultancy

Engineering consultancy is a vital area for ensuring speedy technological and industrial development. It ensures the appropriate utilization of indigenous materials, plant and machinery. Engineering consultancy provides an essential link between R & D instituions and industry, and thus promotes effective transfer of technology. Capability for total systems engineering process development and project management should be developed with collaboration if required. Wherever capability exists, utilisation of Indian consultancy engineering organizations will be promoted. Even where foreign technical collaboration or consultancy is considered unavoidable, association of designated Indian consulting engineering organisations would be preferred. Indigenous engineering consultancy in both private and public sectors, will be promoted on a sound professional basis in the context of the over all national perspective of technological self-reliance.

4.11 In-house R & D

In-house R & D units in industry provide a desirable and essential interface between efforts within the national laboratories and the educational sector as well as production in industry. Appropriate incentives will be given to the setting up of R & D units in industry and for

industry including those on a cooperative basis. Enterprises will be encouraged to set up R & D units of a size to permit the accomplishment of major technological tasks.

5. Technology Acquisition

5.1 Mix. of Indigenous and Imported Technology

A policy directed towards technological self-reliance does not imply technological self-sufficiency. The criterion must be national interest. Government policy will be directed towards reducing technological dependence in key areas.

Advantage should be taken of technological developments elsewhere. This can also be achieved through well defined collaborative arrangements in research and development.

At any given point of time, there will be a mix of indigenous and imported technology. However, technology acquisition from outside shall not be at the expense of national interest. Indigenous initiative must receive due recognition and support.

In the acquisition of technology, consideration will be given to the choice and sources of technology, alternative means of acquiring it, its role in meeting a major felt

need, selection and relevance of the products, costs, and related conditions. A National Register of Foreign Collaboration will be developed to provide analytical inputs at various stages of technological acquistion.

5.2 Principles of Acquisition and Technology Assessment

Where the need to import technology is established, every effort should be made to ensure that it is of the highest level, consistent with requirements and resources. The technology import will be so planned as to have effective transfer of basic knowledge (know-why) and to facilitate further advancement.

Where the import of technology is contemplated, the level to which technology has been developed, or is in current use, within the country, shall be first evaluated. Lists of technologies that have been adequately developed to the extent that import is unnecessary will be prepared and periodically updated; in such areas no import of technology would normally be permited; and the onus will be on the seeker of foreign technology, be it industry or a user Ministry, to demonstrate to the satisfaction of the approval authority that import is ncessary.

Technology assessment system will be reviewed. A technology assessment mechanism consisting of competent

groups will render advice in all cases of technology import relating to highly sophisticated technology, large investments and national security. Aspects of employment, energy, efficiency and environment will be kept in view.

The basic principles governing the acquisition of technology will be: -

(a) Import of technology, and foreign investment in this regard, will continue to be permitted only on a selective basis where: need has been established, technology does not exist within the country; the time taken to generate the technology indigenously would delay the achievement of development targets.

(b) Government may, from time to time, identify and notify such areas of high national priority, in respect of which procedures would be simplified further to ensure timely acquistion of the required technology.

(c) There shall be a firm commitment for absorption, adaptation and subsequent development of imported know-how through adequate investment in Research and Development to which importers of technology will be expected to contribute.

5.3 Unpacking

Technology to fulfil a particular need consists of many components. It is necessary to develop capability to break down the total package of technology required for a purpose into components, some of which may be readily available or could be indigenously developed, and others that will need to be imported. Norms and guidelines for such unpackaging will be evolved.

5.4 Absorption of Technology

There shall be a commitment to ensure an adequate scale of investment in R&D for the absorption, adaptation and, wherever possible, improvement on and generation of new technology, making fullest use of overall national capabilities. Only thus can self-reliance be ensured and a technology generation process established firmly. Appropriate mechanisms will be evolved at the stage of technology assessment to ensure the absorption of imported technology.

5.5 Technological Information

The availability of an efficient system of collection and analysis of relevant technological information, including cost and other economic aspects, is a prerequisite for the appropriate choice of technologies. This will

considerably enhance the possibility of obtaining favourable terms and conditions in acquisition of technology. Such a technology information base will be established.

6. Technology Transfer

6.1 Diffusion

Special efforts need to be made for the diffusion of technology in use to all beneficiaries who can employ them optimally. Appropriate measures shall be evolved to facilitate technology diffusion, including: horizontal transfer; technological support for ancillaries from large units; technology inputs to small units; and upgradation of traditional skills and capabilities.

6.2 International Competitiveness and Technology Exports

In is necessary to maintain international competitiveness in products, services and technologies that have export potential. Conditions for the marketing of indigenous technology and of products based on it will be improved. It is important in all such cases to conform to the highest international standards.

6.3 Technical Cooperation among Developing Countries

A concerted effort will be made to participate fully in technical cooperation among developing countries. Encouragement will be provided for participation in technology development programmes with other developing countries which can contribute to mutual national development.

6.4 Protection : Legislative Framework

Development of technology calls for large investments and often involves considerable risk. Encouragement will be given to obtaining necessary protection in all cases of indigenous technology development. A mechanism will be set up to ensure that national interests arising from the generating of technology are fully protected internationally in terms of industrial property rights.

7. Implementation

The success of the Technology Policy and the speed with which the various facets of the policy are implemented will depend to a considerable extent on a system for efficient monitoring, review and guidance and a scheme of incentives and disincentives.

Government will evolve instruments for the implementation of this Technology Policy and spell out in detail guidelines for Ministries and agencies of Government as well as for industries and entrepreneurs.

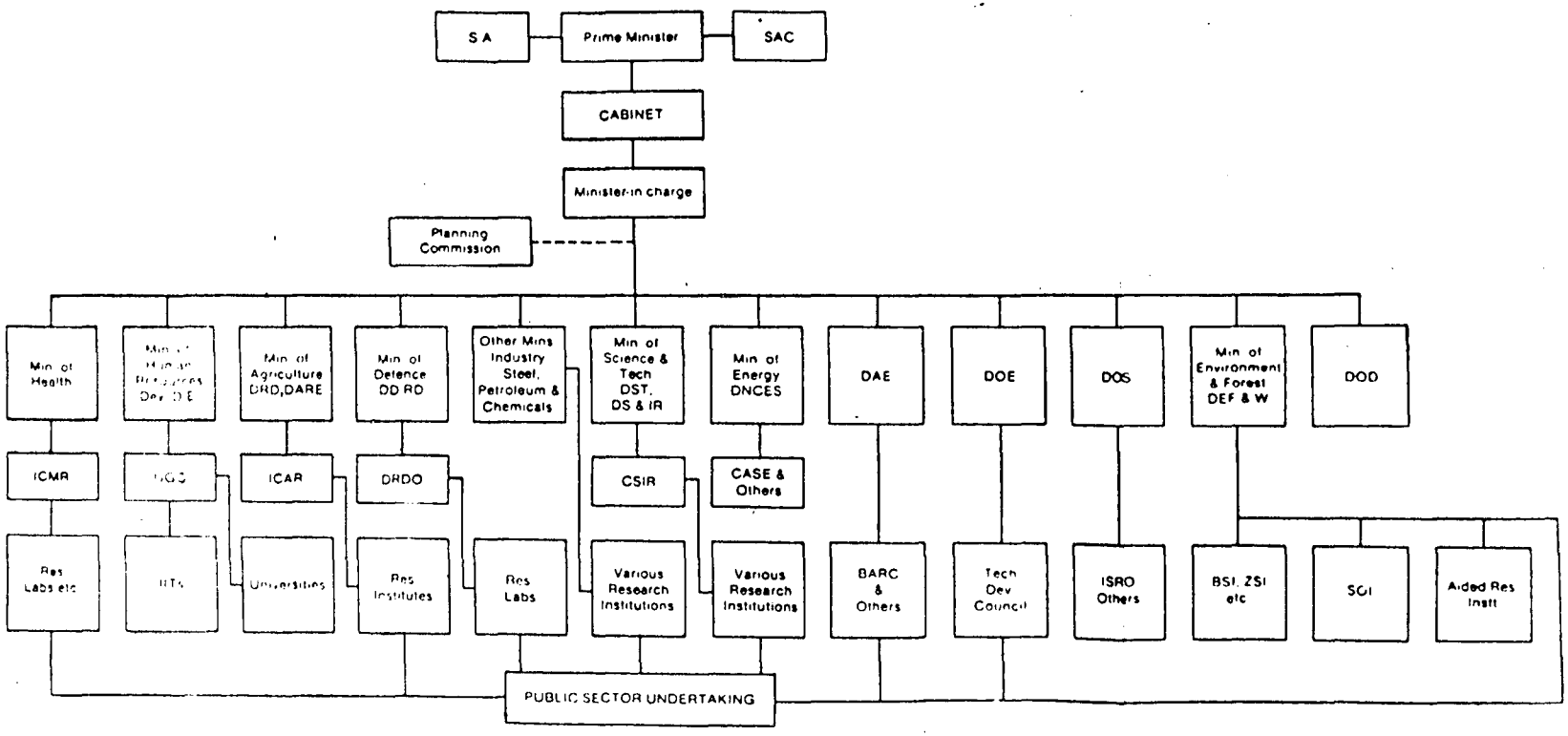
Success in implementation demands a conscious integrated approach covering technology assessment, development, acquisition, absorption, utilization and diffusion and connected aspects of financing, based on overall national interests, priorities and the attainment of the most challenging technological goals.

Above all, the entire population must be imbued with self-confidence and pride in national capacity.

Indian Science and Technology must unlock the creative potential of our people and help in building the India of our dreams.

APPENDIX III

ORGANISATION CHART OF SCIENCE AND TECHNOLOGY, INDIA



ELY

ICMR	Indian Council of Medical Research
SAC	—Science Advisory Council to the P.M.
ICAR	—Indian Council of Agricultural Research
UGC	—University Grants Commission
DAE	—Deptt. of Atomic Energy
DS & IR	—Deptt. of Scientific and Industrial Research
S.A.	—Science Advisor
DARE	—Deptt. of Agricultural Research and Education
DRD	—Deptt. of Rural Development
DDRD	Deptt. of Defence Research Development
DSIR	—Deptt. of Scientific and Industrial Research
DST	—Deptt. of Science & Technology
DRSE	—Deptt. of Renewable Sources Energy
BSI	—Botanical Survey of India
ZSI	—Zoological Survey of India
SOI	—Survey of India
DNCES	—Deptt. of Non-conventional Energy Sources
CASE	—Commission for Additional Source of Energy
DOE	—Deptt. of Electronics
CSIR	—Council of Scientific and Industrial Research
BARC	—Bhabha Atomic Research Centre
DOS	—Deptt. of Space
ISRO	—Indian Space Research Organisation
DOD	—Deptt. of Ocean Development
DEF & W	—Deptt. of Environment, Forests and Wild Life

APPENDIX IV

RESOURCE ALLOCATION FOR SCIENCE AND TECHNOLOGY

(Rs. in crores)

	Plan	Non-Plan	Total
1st Plan (1951-56) . .	14	6	20
2nd Plan (1956-61)	33	34	67
3rd Plan (1961-66)	71	73	144
4th Plan (1969-74)	142	231	373
5th Plan (1974-79)	693	688	1381
6th Plan (1980-85)	1960	1447	3407
6th Plan (1980-85) (Scientific Agencies only)	1158	984	2142
7th Plan (1985-90) (Scientific Agencies only)	2466	2347	4813

For the Three Annual Plans (1966-69), the Plan expenditure was Rs. 47.15 crores.

APPENDIX V

Anticipated Expenditure for the Sixth Plan and Tentative Allocations for the Seventh Plan 1985-90

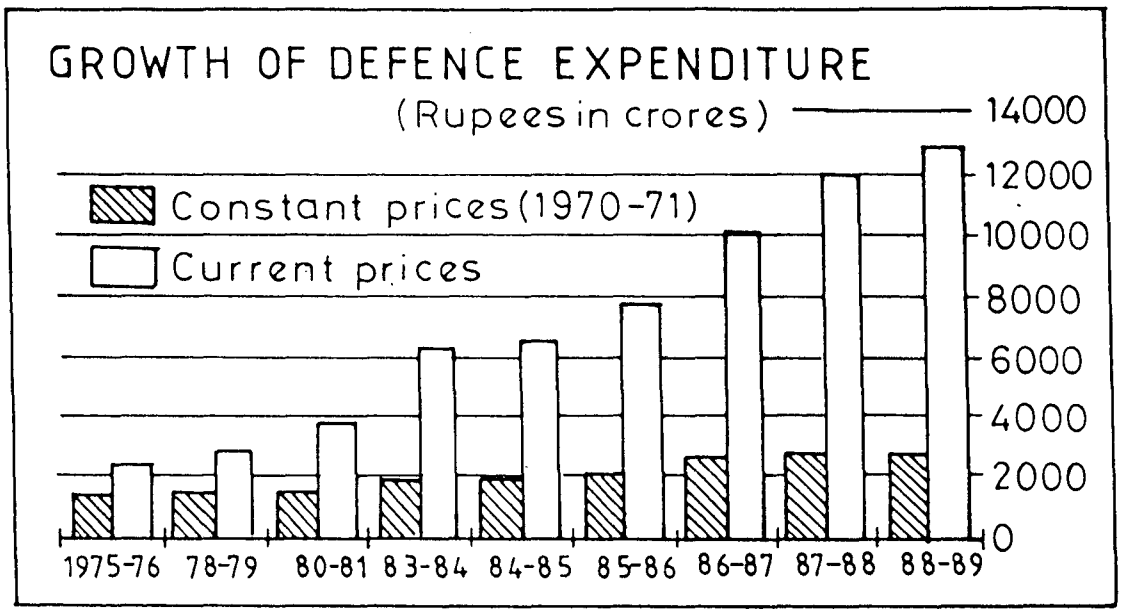
(Rs. in crores)

Sl. No.	Sectors	Sixth Five Year Plan (anticipated expenditure) 1980-85	Seventh Plan outlay 1985-90			
			Total	Centre	States	UTS.
1	2	3	4	5	6	7
1.	Atomic Energy (R&D)	234.59	315.00	315.00	..	..
2.	Environment & Ecology/ Prevention & Control of Air and Water Pollution and Ganga Action Plan	40.05	427.91	350.00	75.71	2.20
3.	Ocean Development (S&T)	87.04	100.00	100.00	..	..
4.	Science and Technology	269.93	543.09	458.43	81.57	3.09
	(a) Meteorology	47.22	88.78	88.78	..	..
	(b) Science&Technology	137.27+	429.66	345.00	81.57	3.09
	(c) Meteorology Component of INSAT Space Segment*	85.44	24.65	24.65	..	..
5.	Scientific and Industrial Research	221.71	355.00	355.00	..	..
	(a) CSIR	220.36	335.00	335.00	..	..
	(b) Schemes transferred from DST to DSIR	1.35**	20.00	20.00	..	..
6.	Space (S&T)	304.56	700.00	700.00	..	..
7.	Forensic Science and Police Wireless		25.00	25.00	..	..
	TOTAL	1157.88	2466.00	2303.43	157.28	5.29

Notes;- + Including Rs. 35.07 crores under States/UTs.
* The Department of Space has operational/budget responsibility for this programme
** RE for 1984-85 only. This does not include Rs.25 lakhs for TAAS which was transferred to DSIR later on.

Source: Seventh Five Year Plan, Vol.II, Annexure 17.2

APPENDIX VI


GROWTH OF DEFENCE EXPENDITURE
(Rupees in crores)
Constant prices (1970-71)
Current prices
14000
12000
10000
8000
6000
4000
2000
0
1975-76
78-79
80-81
83-84
84-85
85-86
86-87
87-88
88-89

APPENDIX VII

DEFENCE DATA : COMPARATIVE STUDY

INDIA

Population: 779.983 million
Total armed forces
Active:1,262,000. Terms of service: voluntary
Reserves:Army 200,000.Territorial Army 40,000. Air Force(Regular, Air Defence,Auxiliary) exist,strengths unknown.

PAKISTAN

Population: 99.705 million
Total armed forces
Active:480,600. Terms of service: voluntary
Reserves:513,000. Army 500,000: obligation to ages 45(men) or 50 (officers);active liability for 8years after service.Navy5,000;Air8,000.

CHINA

Population: 1.08 billion
Total armed forces
Active:some 3,200,000(perhaps 1,350,000 conscripts - men&women aged 18-22),being reduced
Terms of service:selective conscription; Army, Marines 3Years;Navy 5years,Air Force 4years.Technical volunteers can serve 8-12 more years to maximum age 35.
Reserves: 4,400,000(obligation to age 45); with service in past 5 years: Army1,800,000; Navy 115,000;Marines?50,000; Air(AD)200,000; see also paramilitary.

STRATEGIC FORCES

OFFENSIVE(Strategic Rocket Units):(90,000).
(a) Missiles:org in 6(perhaps 7)divs with regts or bdes and bns;org varies by msl type
ICBM:6:
2 DF-5(CSS-4)(Dong Feng=East Wind; mod testes with MIRV.
4 DF-4(CSS-3).
IRBM:60 DF-3(CSS-2), some updated.
MRBM:50 DF-2(CSS-1)(may now be retiring).
(b) Subs:
2 Xia SSBN each with12 JL-1(CSS-NX-4,mod DF-3)(Julang=Giant Wave).Range est 2,200-3,000km, possibly 1x2 MT warhead; in testing and evaluation.
(On order: 8SSBN; (more planned);some ?Daqingyu, may have 16 launch tubes).

DEFENSIVE:
(a) Tracking stations: Xinjiang(covers Central Asia) and Shanxi(northern border).
(b) Phased-Array radar complex. Ballistic Missile early warning.

INDIA

ARMY: 1,100,000.
HQ: 5 Regional Comd(=Fd Army),
9 Corps
2 armd divs(Type:2Tk, 1 mech bdes, SP arty, engr, sigs regts)
1 mech,div.(3 mech bdes,SP arty,engr sig,regt
20 inf divs(Type:3 inf bdes[9 bns],armd,arty, engr, sigs regts; hy divs may have 4 or 5 bdes)
9 mountain divs(Type:3 bdes,mountain arty sigs, engr regts)
19 indep bdes:7 armd,10 inf, 1mountain, 1 para/cdo
10 indep arty bdes
5 AD bdes
3 army engr bdes
These formations comprise: 46 tk regts
17 mech, 329 inf. bns.
9 Para/cdobns; 164 arty regregts
1 hy; SMRL; 50 med.(incl.5 SP),
39 mountain
29 AA arty regts, perhaps 10 SAM groups (3-5 btys each).
Avn: 29 air observation/fire control flts (hy hel. units to form)

PAKISTAN

ARMY: 450,000.
7 Corps HQ
2 armd divs.
17 inf divs.
4 indep armd bdes.
8 indep inf bdes
8 arty bdes/bdes equivalents
3 AA arty bdes
6 armd recce regts
1 special services group(3bns)
EQUIPMENT:
Tks:1600; 450 M-47(incl A5);51 T-54/-55 some 1100 Type-59
lt. Type-63
APC: 800 M-113, 45 UR-416,Type-531 reported
Arty: guns: 85mm 180 Type 56; 88mm some 1,000 25-pdr; 100mm :Type-59; 130 mm Type-59-1/M46; 5.5 in.(140mm) and 155mm: M-59
How:105 mm 200; 12 M-7 SP;
50 M-56 pack; 122mm : 100Type 54-1; 155mm:60 M-114,95 M-198 towed, 64 M-109A2 SP, 203mm: 40 M-110A2 SP
MRL : 122mm: BM-21

CHINA

(c) Air Force AD system:
i) Over-the-Horizon - Backscatter (OTH-B) radar system. Range 700-3,500 km, 60° arc of cover.
ii) over 4,000 Naval and Air force fighters;
iii) about 100 HQ-2J(C(Hongqi = Red Flag SA-2-type) SAM units;
iv) over 16,000 AA guns; capable of limited defence of key urban and industrial areas, military installation and weapons complexes.
(d) A civil-defence shelter/evacuation/ local defence system in Peking and othe key cities.

ARMY: 2.300,000(perhaps 1,075,000 conscripts),(reduction continue).
Main Force: 7 Military Regions, 29 Military Districts(Provincial Regions), 1 indep MD, 3 Garrison Comds.
Integrated Corps: Some 28 Corps(46,300 men; being reorganised) comprising 118 inf divs (some being mech ['all arms'])
Spt elms, assigned to Corps as required
13 armd divs(normally 3 regts,323 MBT)
Some 17 field arty divs
16 AA arty divs
Some indep arty AA regts
Some 21 sigs, CW regts
50 indep engr regts
20 indep recce,engr, sigs, chemical bns
Former Regional Forces: now 'People's Armed Police' (PAP) under Army control. See 'Paramilitary' below.

EQUIPMENT: Tks: 11,450
T-54(?trg), 6,000 Type-59
250 T-69(mod Type-69; not incl. T-69 II, which is export only)
lt.: 1,200 Type-62; 800 Type-63 amph

INDIA

EQUIPMENT

Tks: 2,750 (?500 in reserve), some 800 T-55 350 T-72, 1,500 Vijayanta
lt.: 100 PT-76
AFV:MICV: 600 BMP-1
APC: 350 OT-62/-64, 360 BTR-60
Arty:guns: some 2,165 (some 100 SP): 76mm:200 Yug M-48; 88mm:800 25-pdr (reiring); 100mm:185 M-1944; 105mm:340 incl. Abbot SP; some 30 IFG Mk II; 130mm 500 M-46 (some 100 SP); 140mm:140 5.5-in (retiring).
how: some 1,710: 850:75mm: 75/24 mou -ntain; 105mm: 860 (incl M-56 pack); 155mm:some FH-77B.
MRL: 122mm: 120 BM-21
mor: 81mm, 120mm,: 500; 160mm: 50
ATK:RCL: 57mm:M-18; 84mm:Carl Gustav; 106mm:M-40.
ATGW: SS-11-B1, Milan, AT-3Sagger
AD: guns: 2,665:23mm: 180-ZU 23-2, 50 ZSU-23-4 SP; 40mm: 1,245 L40/60, 790 L40/70; 94mm: 500 3.7-in.
SAM:120 SA-6, SA-7, 48 SA-8A, SA-9, 18 Tigercat launchers.(on order Arjun, 1,550 T-72M MBT; SBRDM recce; BMP-1/-2, MICV; some 370 IFG 105mm Mk II guns; some 400 Bofors FH-77B 155mm how SA-8 SAM)

NAVY: 47,000, incl naval air force, 3 regi onal, 1 submarine commands, 3 fleets.
Bases: Western Fleet: Bombay(HQ),Goa, Kerwer (building), Southern Fleet: Cochin(HQ), Eastern Fleet: Vishakapatnam(HQ), Calcutta, Port Blair.
Subs: 11: 8 Sov F-class (to be replaced by K-class), 1 K-class; 2 Type-1500 Sishumar(=baby shark)
Carrier: 2 Br Hermes-class(capacity 5V/STOL, Sea Harruer attack ac; Alize ac, Sea King ASW hel).

PAKISTAN

EQUIPMENT - Cont'd

Mor: 81mm/82mm; 107mm,120mm
ATK:RL:89mm:3.5-in.RCL:75mm:Type-52
106mm: M-40A
ATGW: Cobra,224 TOW (incl 24 on M-901SP)
AD:guns: 14.5mm; 35mm; 37mm;Type-55/-65; 40mm:M1; 57mm:S-60/Type-59
SAM: 100 Stinger, 144 RBS-70.

AVIATION:
Liaison:ac: 1 sqn with 55 Mashshaq(Saab-91 Safari); hel:4sqns.
Observation: indep flts:
ac: 45 O-1E, Cessna 421, 50 Mashshaq Turbo Commander, Queen Air;
hel: 20 AH-1S Cobra with TOW, 16 Mi-8,35 SA-330 Puma, 23 SA-316B Alouette III, 13 Bell-47 (on order: 88M-109A2SP how)

NAVY: 13,000 (incl Naval Air)
Base: Karachi
Subs: 8: 6Fr-2 Agosta, 4 Daphne;2 SX-404 midget
Destroyers: 7: 1 Br County with 2x4 Seacat SAM, 1 Aluette hel; 6 US Gearing with 1x8 ASROC ASW;
FAC(G): 8 Ch:
4 Huangfen(4 HY-2 SSM), 4 Hoku (2 HY-2)
FAC(T): 4 Hunchwan hydrofoil .
FAC: 12 Sanghai-II.
Patrol craft, large: 5: 4 Ch Hainan, 1 Br Town
MCMV: 3US:2 Adjutant, 1 MSC-268 coastal
Spt: 1 tanker, 1Br Dido Cruiser, 1 Br Battle destroyer(non-operational trg ships)
(on order: 3 Br Type-23. 2 Neth M-class frigates, 2 more planned; 16 RGM-84 HarpoonSSM)

NAVAL AIR: 3 combat ac,10 armd hel.
ASW/MR: 1 sqn with 3 Atlantic([AM-39 ASM] operated by Air Force)
ASW/SAR: 2 hel sqns with 6 Westland Sea King ASW with AM-39, 4 SA-316B Aluette III.

CHINA

EQUIPMENT - Cont'd

AFV:ARC:2,800 Type-531,Type-85(YW-534)
Type-55(BTR-40)/-56(BTR-152)/-63, Type-77 -1/-2(Sov BTR-50PK amph),Type-523,6x6 wheele with 12.7mm hy machine gun
Arty: 12,800
guns: 85mm: Type-56; 100mm:Type-59(fd/ATK
122mm: Type-60; 130mm:Types-59/-59-1;
152mm : Type-66
how: 122mm: Type-54, Type-54-1 SP (Type-531 chassis); 152mm: Type-54, Type-66;Type-83 SP.
MRL: 4,500: 12x107mm: Type-63/-81 (being replaced by 122mm); 24x122mm:Type-83, Type-81 minelayer; 40x122mm:Type-81 19x130mm: Type-63; Type70SP; 30x130mm Type-82; 16x132mm:BM-13-16; 16x140mm:BM-14-16; 4x273mm:Type-83; 10x284mm:Type-74 mine layer.
Mor: 14,000:82mm:Type-53/-67, W-84 and SP 100mm: Type-71; 120mm:Type-55 & WZ-381 SP 160mm: Type-56, N-160(?Type-60).
(SSM: Type-M (Scud B type)under development - in service ?1989)
ATK: grenade launchers: 40mm: Type-56,-69; 62mm:Types-69-1/-70-1.
RCL: 57mm: Type-36; 75mm: Type-52/-56; 82mm: Type-65; 105mm:Type-75 SP.
RL: 90mm: Type-51
guns: 57mm:Type-55; 76mm: Type-54
ATGW: HJ-73 (Hongjian=Red Arrow, Sagger-Type HJ-8 (TOW/Milan-type)
AD:guns: 15,000: 12.7mm:Type-54, -77;14.5mm: -75,-75-1 towed, Type-56,-58,-80 twin SP; 23mm: 9zsu-23 type); 37mm: Type-55, -63 Twin SP; 57mm: Types-59;-80 SP; 85mm: Type-56; 100mm: Type-59 .
SAM: HN-5, HN-5A/-C(SA-7 type); HJ-61TwinSP

DEPLOYMENT (current re-org may alter totals)
Excl. arty & AA divs Integrated Corps may be : North-East: Shenyang MR(Heilongjiang, Jilin, Liaoning MD): 5 Corps, , ? 2 MSL, 23 inf.

INDIA

Destroyers: 4 Sov Kashin II DDG with 4 Styx SSM, 2x2SA-N-1 SAM,1 Ka-25 Hel.
Frigates:21: 2 Godavari(mod Leander) with 2 Styx SSM, 1 SA-N-4 SAM, 2 Sea King hel;
6 Br.Leander(4 with 2x4, 2 with 1x4 Seacat SAM, 1 Alouette or Sea King hel);
2 Br Whitby with 3 Styx SSM, 1 SA-316B Alouette Hel;
8 Sov Petya II (to be replaced)
3 Br Leopard (trg)
Corvettes: 4 : 3 Sov Nanuchka II with 4 SS-N-2 SSM, 1 SA-N-4 SAM;
1 Veera.
FAC(G): 14 : 6 Sov Osa-I, 4 Osa-II, 4 Styx SSM.
Patrol craft: 9 : 6 SDB-2, 2 Osa-I, 1 Abhoy.
MCMV: 18 : 8 Sov Natya ocean; 4 Br Ham, 6 Sov Yevgenya inshore hunters.
Amph: LST:1; LCT: 8(2 Sov, 6 Pol Polnocny); LCU: 4 Da Gama

NAVAL AIR FORCE: (2,000), 21 combat ac, 29 armed hel.
Attack: 1 sqn with 8 Sea Harrier FRS Mk-51, 2 T-60 trg (more being delivered).
ASW: 1 ac sqn with 5 Alize 1050 (in carriers) 5 hel sqns with 5 Ka-25 Hormone A (in Kachins , Ka-27 to replace), 9 Sea King, 1 1 SA-316B Aloutte III (in frigates)
MR: 2 sqns3 II-38 May, 3 Tu-142M Bear.
Comms: 1 sqn with BN-2 Defender (?2 MR).
SAR: 1 hel sqn 10 Aouette III.
Trg: 2 sqns 7 HAL HJT-16 Kiran, 10 BN-2 Islander ac; 4 Hughes 300 hel.
Other ac incl: ASW: 5 Alize 1050,4 Sea King hel.
(on order: 4 Sov F-, 5 K-class, 2 Type-1500 subs [2 more planned]; 2 Kashin DDG; Godavari FFG (1987), 4 Khukri, 1,200-ton, 3 Nanuchka, 5 Tarantul corvettes; 6 SDB-3 FAC; 4 Natya MCMV; 4 Olnocny LCT; 2 LST; 4 LCU; 1 survey ship; Exocet SSM; 7 Sea Harrier Mk 51, 1 T-60; 3 Tu-142M Bear, 26 Dornier Do-228 MR ac;

PAKISTAN

Comms: 1 Fokker F-27 ac (Air Force)
ASM:AM-39 Exocet

AIR FORCE: 17,600; 381 combat ac, no armed hel. FGA: 107 ac , 8 sqns; 1 with 16 Mirage IIIEP (some with AM-39 ASM); 4 with 50 Mirage 5PA3; 3 with 41 Q-5.
Interceptor/FGA: 209 ac: 11 sqns: 9 with 170 J-6; 2 with some 39F-16
Recce: 1 sqn with 13 Mirage IIIRP
Tpt: 2 sqns: 1 with 13 C-130B/E, 1 L-100 Hercules; 1 with 1 Mystere-Falcon 20, 2 F-27-200 (1 with Navy), 2 Beech (1 Super King Air, 1 Bonanza).
SAR: 1 hel sqn with 2 HH-43B, 4 SA-316B Alouette III.
Utility: 1 hel sqn with 4 SA-321 Super Frelon, 12 Bell 47.
Trg: 1 sqn with 20 T-33A / 4 Ch MIG-15UTI; other ac incl 2 Mirage 5DPA2, 3 Mirage IIIDP, 2 J-6, 35 Cessna T-37C, 45 JJ-5 (MiG-17U), 12 CJ-6, 24 Reims Cessna FTB-337.
AD: 7 SAM btys: 6 with 6Crotale (each 4 msls); 1 with 6 CSA-1(SA-2).
AAM: Sidewinder, R-530, R-550 Magic
ASM: AM-39 Exocet.
(on order: 10 F-16, some 100 Q-5 FGA, 60 Xian J-7; some 300 AIM-9LSidewinder)

Forces Abroad: 30,000 contract personnel Saudi Arabia (10,000),Libya,Oman, UAE, Kuwait.
Paramilitary: 164,000.
National Guard (75,000): Mujahid Force Janbaz Force, National Cadet corps; Women Guards.
Civil Armed Forces (89,000): Frontier Corps(65,000) UR-416 APC.
Pakistan Rangers (15,000); Northern

CHINA

North: Beijing MR (Peking, Tianjin Garrison Comds:Nei Monggol,Hebei, Shanxi MD): 6Corps, 1 msl,4armd, 25 inf; 1 AB (Air Force);
West: Lanzhou MR (incl. Ningxia, Shaanxi, Gansu, Qinghai,North,South & East XingjiangMD) 3 Corps, 2 msl, 1 armd, 13 inf;
South-West: Chengdu MR (inclSichuan, Sanxia, Guizhou, Yunnan, Xizang MD): 3 Corps, 1 msl, 15 inf;
South: Guangdong MR(Hubei, Hunan,Guandong, Guanxi, Hainan [MD-equivalent]):4 Corps, ? 16 inf;
Centre: Jinan MR (Shandong, Henan MD): 3 Corps 2 armd, 10 inf, 3 AB (Air Force);
East: Nanjing MR (Shanghai District, Jiangsu, Zhejiang, Fujian, Jiangxi, Anhui MD): 4 Corps, 1 armd, 16 inf.

NAVY: 340,000 incl Coast Defence, Marines & Naval Air(some 115,000 conscripts); 3 SSQ; 53 major, some 1,000 minor surface combatants. Bases: see Deployment & Bases below.
Subs: 117: SSGN: 3Han with 6 SY-2 Cruise missiles
SSG (trials): 2: 1 Type-200 'Wuhan' (sov G-class), with 4 ?SY-2 or C-801 SSM. 1 Type-031 (Sov R-class mod) with 6-8 C-801/SY-2SSM
SS: 112: 90 Type-033 (Sov R-class), 20 W-IV/-V-class) trg. 2 Ming (R-class mod) trg.
Principal Surface Combatants: 53
Destroyers: GW: 20:
16 Type-051 Luda (Kotlin-type) with 2x3 fl-1 SSM; 1 trials with 4 YJ-6 SSM;
4 Anshan (ex-Sov Gordy) with 2x2 FL-1.
Frigates: 33: 28 GW: 22 Types-037 Jianghu & -053H mod Jianghu with 2x2 YJ-6 or FL-1 SSM, 1 with 1 Harbin Z-9 hel. 2 Type-053J Jiangdong, 1 with 2x2 HQ-61 SAM; 4 Chengdu (ex-Sov Riga) with 1x2 FL-1 SSM; 5 Jiagnan (Riga-type).
Minor surface combatants: some 1,000.

INDIA

8 Ka-27 Helix, 12 Sea King Mk 42B ASW, 6 Sea King Mk 42C utility hel; Sea Eagle SSM; AM-39 Exocet ASM)

AIR FORCE: 115,000; some 701 combat ac, some 60 armed hel. 5 Air Commands

Bbrs: 53 ac: sqns (1 maritime role) with 35 Canberra B(1)58/B(1)12 (to be replaced), 18 Jaguar.

FGA: some 396 ac: 11 sqns:
2 with some 40 Mirage 2000H;
3 with 61 Jaguar GR-1, 6T-2;
5 with 60 MiG-21;
2 with 44 MiG-29 Fulcrum;
4 with 72 Ajeet;
5 with 95 MiG-23BN Flogger H;
2 with some 24 MiG-27 FloggerD/J;
AD: 165 ac: 8 sqns
2 with 45 MiG-23MF Flogger B;
6 with 120 MiG-21/fl3pfma3-MF/bis;
Air Defence Ground Environment System

Recce: 19 ac: 3 sqns:
1 with 8 Canberra PR-57;
1 with 6 MiG-25R, 1 MiG-25U;
1 with 4 HS-748.

Tpt: ac; 11 sqns
5 with 93 An-32 Sutlej;
2 with 30 An-12B;
1 with 20 DHC-3 Otter;
1 with 16 DHC-4 Caribou;
2 with 16 HS-748, 2 Boeing 737-248 (leased), 8 Il-76 Gajraj;
hel: 6 sqns with 72 Mi-8/-17, 2 Mi-26 hy tpt 12 Mi-25.
Comms: 1 HQ sqn with 7 HS-748M.

Liaison ac flts and dets: 16 HS-748, C-47 (DC-3).
Liaison hel: 7 sqns (army-assigned; some with 4 AS-11B ATGW); 3 with 99 SA-316B Chetak (AlouetteII);

PAKISTAN

Light Infantry (7,000), Coast Guard (2,000).

CHINA

(Some minor combatants are reportedly being assigned to paramilitary duties - People's Armed Police, border guards and the militia - or into reserve; totals should be used with caution).

Patrol escorts: 13: 9 ex-Jap, 1 ex-Br, 1 ex-Aus, 2 Ch (probably in reserve).
Patrol Craft, large: 81: 60 Hainan, 1 Haijai (mod Hainan) , 20 Kronshtadt;
coastal/river: some 89: 1 Beihai, 40 Huangpu 40 Yulin & Yingkou (with militia) 8 other.
FAC (G): 223 with F1-1 or YJ-6 SSM
120 Osal/Huangfen (4 or 8 msls), 1 H-3 Haija (4 or 8 msls)(replacing Osa), 1 Hola, 110 Houku (Hegu); 1 Houma hydrofoil (2 msls).
FAC: 355:
290 Shanghai I/II/III/IV/V. 3 Haikou, 60 Shantou; 2 Shandong hydrofoils.
FAC (T): 190: 110 Huchwan I/II hydrofoils; 60 P-6, 20 P-4 (?all in reserve); new 25-m class (?Zaqiang) reported
MCMV: 33 T-43 ocean minesweepers.
Amph: assault tpt: 4 Qiong Sha, 2,500-ton;
LST: 17:4 Yukan/Zoushan, 13 Shan (ex-US 1-511, -542); (1,500-ton Chang Ming reported);

LSM: 46: 14 Hua (ex-US LSM-1), 30 Yuliang and 1 Yuling, 1 Yudao experimental
LSI: 4 Min(ex-Us LSIL);
LCU: 370: 300 Yunnan, 45 Yuchin,25 Yuchai,
LCT: 9 (2 ex-Br/ex-US)
LCM: 165 (140 ex-Br/US)
SES (LCAC): Dagu, Bayi,Type-722 Jingsa Types.
Spt: 10 sub (incl 1 repair), 6 other, 10 supply ships, 23 tankers, 1 V-856 trg.
Augmentation: perhaps 800 ocean-going vessels fishing trawlers and several thousand junks could augment existing limited sea-lift capacity.
Msls: SSM: coastal: HY-2(Haiying=Sea Eagle; US=Silkworm, Styx-type); HY-3 (?/C-101); HY-4 (Styx-type med-range coast def msl)

4 with 60 SA-315B Cheetah (Lama).

Trg Comd:
11 Canberra T-4/-13/-67, 20 Hunter T-66, 30 MiG-21/U, 13 MiG-23UM Flogger C/L; 5 Jaguar, 9 Mirage 2000H, 60 HT-2, 83 Kiran, some 20 HAL HPT-32 (replacing HT-2), 44 PZL TS-11 Iskra, 27 HS-748 ac; 20 Chetak hel.
AAM: R-23R/T Apex, R-60 Aphid, R-550 Magic, AA-2 Atoll
ASM: AS-30; AS-11B(ATGW), AS-7 Kerry (with MiG-27)
SAM: 30 bns; 280 Divina V75SM/VK(SA-2), SA-3.

(on order: some 40 MiG-29, 31 Jaguar [to be locally assembled], some 165 MiG-27M, MiG-21 bis ftrs; 30 An-32, some 20 Il-76, 116 Do-228 tpts; 90 Kiran Mk 2, some 120 HPT-32 trg ac; 6 SA-385 Dauphin, 21 W-30, Mi-17, 10 Mi-26, 45 Chetak hel; R-23R Apex, R-60 Aphid AAM.)

Paramilitary:

National Security Guards: anti-terrorism contigency deployment force. Comprises elements of the Armed Forces Border Guard, Central Reserve Police Force (CRPF): 80,000; 83 bns.

Border Security Force: 90,000; some 95 bns (to add 49 bns by 1991), small arms, some lt arty, tpt/ liaison air spt.
Assam Rifles: 37,000

Indo-Tibetan Border Police: 14,000

Other groups (total strength perhaps 150,000) incl: Special Frontier Force, Central Industrial Security Force: (53,000), Defence Security Force, Raiway Guard forces, Public institutinal guards.

Coastguard: 2,000; 2 Br Type 14 frigates, patrol vessels (4 P-957 offshore, 4 SDB-2 fast, 21 inshore incl 1 new Tara Bai class);

2 air sqns with 2 Fokker F-27, 5 BN-2 Defender ac, 4 Chetak hel.

sea-launched: FL-1(Feilong=Flying Dragon; Styx-type); HY-5(YJ-6 Yingi=Eagle Strike=C-801).
SAM: HJ-61 (Hongjian=Red Arrow); rail-launched, radar-guided ship - and truck-mounted msl (?mod HQ-2J).
SLCM: SY-2 sea skimmer (?Exocet-type) reported; may be HY-5.
(on order [tentative]: 3 Han SSN; 9 Type-033 SS; 6 Jianghu[4 IV and V mods], 2 Jiangdong FFG; H-3 Hegu FAC: " Cougar Marine patrol catamarans, 1 MCMV; 2 Qiongsha assault tpts, 2 Yukan LST.)

COASTAL REGIONAL DEFENCE FORCES:(38,000).
?35 indep arty and SSM regts deployed near naval bases, offshore islands and other vulnerable points.
Guns: 85mm, 100mm, 130mm.
SSM: HY-2('CSS-N-2'), -3, -4, SY-1 and SY-2/C-801.
MARINES (Naval Infantry): (56,000) (30,000 conscripts)
9 regts (3 cadre divs): 4 inf,3 tk, 3 arty bns; spt elms.
Special recce units.
Reserves: On mobilisation to total 8 divs (24 inf, 8 tk, 8 arty regts), 2 indep tk regts.
3 Ground Force (Army) divs also have an amph role.
Equipments:
Tks: 600 T-59, lt: T-60/-63, PT-76.
APC: Type-531, LVT; some (?Type-77).
Arty:how: 122mm: Type 54 (incl -54-1SP). MRL:Type-63.

NAVAL AIR FORCE: (34,000); about 800 shore-based combat ac, no armed hel. Org. in 3 bbr, 6 ftr divs
incl: Bbrs: some 50 H-6 (Hong=bbr), some H-6D reported with C-601 anti-ship ALCM, About 130 H-5 torpedo-carrying and lt bbrs.
Ftrs: some 600, incl J-2(MiG-15)/-5/-6/-7 (Jian=ftr).
Recce: H-5
MR/ASW: 8 ex-Sov Be-6 Madge and 4 SH-5 (Y-8 mod). 1 PS-5 bbr/ASW (on trials); Y-8MP (Ch version of An-12)(on trial).
Hel:50 Z-5(Zhi=hel), 12 SA-321 Super Frelon ASW. 1 Harbin Z-9 (AS-365 Dauphin) on trial.
Misc: some 60 lt tpt ac; JJ-5/-6 (2-seat) trg ac.

(on order: 2 P-957 off-shore, 5 inshore patrol vessels [4 more planned], 9 lt tpt ac, 6 hel.)

ALCM: FL-1/C-601, FL-7.
Naval fighters are integrated into the national AD system.
DEPLOYMENT AND BASES:
Northern Naval Region:
North Sea Fleet: about 500 vessels (over half<), incl 1 sub flotilla (2 sqns), 2 SSN, some 5 DDG; from the Yalu River to south of Lainyungang.
Bases: Qingdao (HQ), Ludda, Lishun, Huludao, Weihai, Chengshan.
Marines: 1 cadre div.
Coastal Defence Regional Forces: Shenyang, Jinan coastal Districts.

East Sea Fleet: about 750 vessels (about 400<)incl some DDG air, AD and coastal missile units; from south of Liangungang to Dongshan.
Bases: Ningbo (HQ), Zhoushan, Taohua Dao, Heimen,Wenzhou, Fuzhou.
Marines: 1 cadre div
Coastal Defence Regional Forces: Nanjing,Fuzhou coastal Districts.

South Sea Fleet: about 600 vessels (some half<), incl 2 sub flotillas (25 subs) 5 DDG, 200 FAC, amph; from Dongshan to Vietnamese frontier.
Bases: Zhanjiang (HQ), Shantou, Canton, Haikou, Yulin, Beihai.
Marines: 1 div (-).
Coastal Defence Regional Forces: Canton coastal District.

AIR FORCE: 470,000, incl strategic forces and 220,000 AD personnel (160,000 conscripts; some 5,380 combat ac, no armed hel.
7 Military Air Regions, HQ Peking
Combat elms org in Armies of varying numbers of air divs(each with 3 regts of 3 sqns of 3 flts of 4-5 ac, 1 maintenance unit, some tpt and trg ac). Tpt ac in regts only.
Med bbrs: 120 H-6 (some may be nuclear capable). some to be converted to tkr.
Lt bbrs: some 500 H-5 (some with C-801 msl).
FGA: 500 Q-5 (Qiang=attack).
Ftrs: ?4,000, incl 400 J-5, some 60 regts with about 3,000 J-6/B/D/E, 200 J-7/J-7M, 30 J-8.
Recce: ?130 J-5, 90 JZ-6(J-6 variant), 40 HZ-5(H-5 variant) ac.
Tpts: some 550, incl. ?300 Y-5/An-2(Yun=tpt), ?20 Y-7 (An-24) 12 Y-8(An-12), ?75 ex-Sov Li-2(DC-3 type),I1-14, I1-18 (to be retired), 18 BAe Trident.
(It is reported that some 200 tpt ac, types unspecified are to be transferred (with crews) to civil aviation)
Hel: 400: incl. Z-5/-6 (mod. Z-5), Z-9 (SA-365N Dauphin), SA-316B Alouette III, SA-321 Super Frelon, 4 Bell 214-ST, 6 AS-332 Super Puma, 24 Sikorsky S-70.
Trainers: 1,500 (some OCU) incl. CJ-5/-6 (mod CJ-5), MiG-15UTI, JJ-4/-5/-6 (mod J-4/5/6), HJ-5 (H-5 trg)
Msls: AAM: PL-2/-2A, Pl-5B Atoll-type, PL-7 (Plili=Thunderbolt).
ASM(anti-ship): C-601 subsonic ALCM(HY-2 SSM derivative); C-801 surface skimmer.

AB: 1 corps of 3 divs: 1 indep. div. Spt tps incl. comms, engr and CW units.
Eqpt: 82mm, 120mm mor, 82mm RCL, 37mm AA guns.
AA arty: 20 divs: 16,000 57mm, 85mm and 100mm guns; 28 indep AD regts (100 SAM units with HQ-2, -2J (CSA-1), -61 SAM).
(On order: 3 CL-600/601 Challenger ac; 4 S-76 hel.)

Paramilitary: some 12,000,000, People's Armed Police: (1,850,000).
29 divisions, 1,029 bns(border)/mountain/internal defence.
Deployment unknown but probably parallels the previous Regional Force pattern.

MILITIA (Ministry of Defence).

Basic Militia: some 4.3 million; men and women aged 18-28 who have had or will have, military service, grouped in the Armed Militia; serve with the Active forces for 30-40 days per year;
org into about 75 cadre divisions and 2,000 regts, a Naval(Maritime) Militia (?700,000) with (?5,000) armed trawlers, small craft and a major AD component.
Ordinary Militia: up to 6 million (ages 18-35), incl. the Urban Militia receive some basic training but are generally unarmed. Some play a local AD role; all support the security forces.

* The term 'People's Liberation Army' comprises all services; its Ground, Naval and Air components are listed separately for purposes of comparison.
+ There are 2-3 divs. worth of border tps in these MR.
‡ Many Chinese aircraft designs stem from Soviet types. Using Chinese terms, H-5=Il-28, H-6=Tu-16, J-5=MiG-17, J-6=MiG-19, Q-5=MiG-19 derivative, Y-5=An-2, Y-7=An-24, Y-8=An-12, CJ-5=Yak-18A ac; Z-5=Mi-4, Z-6=turboshaft Mi-4, Z-8=SA-321, Z-9=AS-365 hel. In export models the J is generally read as F.

MILITARY ABBREVIATIONS

AA	anti-aircraft
AAM	air-to-air missile
AB	airborne
ABM	anti-ballistic missile
ac	aircraft
AD	air defence
AEW	airborne early warning
AFV	armoured fighting vehicle
ALBM	air-launched ballistic missile
ALCM	air-launched cruise missile
amph	amphibious
APC	armoured personnel carrier
armd	armoured
art	artillery
ASM	air-to-surface missile
ASW	anti-submarine warfare
ATGW	anti-tank guided weapon
ATK	anti-tank
Aus	Australian
AWACS	airborne warning and control system
bbr	bomber
bde	brigade
bn	battalion or billion
Br	British
bty	battery
cav	cavalry
cdo	commando
Ch	Chinese
comd	command
COIN	counter-insurgency
comms	communications
coy	company
CW	chemical warfare
det	detachment
div	division
ECM	electronic counter-measures
ELINT	electronic intelligence
elm	element
engr	engineer
eqpt	equipment
EW	early warning
excl	excludes/excluding
FAC(G)	fast attack craft(gun)
FAC(M)	fast attack craft (missile)
FAC(P)	fast attack craft patrol
FAC(T)	fast attack craft (torpedo)
fd	field
FGA	fighter, ground-attack
flt	flight
GLCM	ground-launched cruise missile
GP	general-purpose
gp	group
GW	guided weapon
hel	helicopter
how	howitzer
hy	heavy
ICBM	inter-continental ballistic missile
incl	includes/including
indep	independent
inf	infantry
IRBM	intermediate-range ballistic missile
km	kilometres
KT	kiloton(1,000 tons TNT equivalent)
LCA	landing craft, assault
LCG	landing craft, gun
LCM	landing craft, medium/ merchandised
LCT	landing craft, tank
LCU	landing craft, utility
LCVP	landing craft, vehicles and personnel
LHA	amphibious general assault ship
log	logistic
LPD	landing platform, dock
LPH	landing platform, helicopter
LSD	landing ship,dock
LPH	landing platform, helicopter
LSM	landing ship, medium
LST	landing ship, tank
lt	light
MARV	manoeuvrable re-entry vehicle
MBT	main battle tank
MCM	mine counter-measures
mech	mechanised
med	medium
MICV	mechanised infantry combat vehicle

.....contd.

MIRV	multiple independently targetable re-entry vehicle
Mk	mark(model number)
mod	modified/modification
mor	mortar
mot	motorised
MR	maritime reconnaissance
MRBM	medium-range ballistic missile
MRCA	multi-role combat aircraft
MRL	multiple rocket launcher
MRV	multiple re-entry vehicle
msl	missile
MT	megaton(1 million tons TNT equivalent)
n.a.	not available
nms	nautical miles
OCU	operational conversion unit
org	organised/organisation
para	parachute
pdr	pounder
RCL	recoilless launcher
recce	reconnaissance
regt	regiment
RL	rocket launcher
RV	re-entry vehicle
SAM	surface-to-air missile
SAR	search and rescue
sigs	signals
SLBM	submarine-launched ballistic missile
SLCM	sea-launched cruise missile
Sov	Soviet
SP	self-propelled
spt	support
sqn	squadron
SRAM	short-range attack missile
SRBM	short-range ballistic missile
SSBN	ballistic-missile submarine, nuclear
SSM	surface-to-surface missile
SSN	submarine, nuclear
sub	submarine
TA	Territorial Army
tac	tactical
tk	tank
tp	troop
tpt	transport
trg	training
UNIFIL	UN Interim Force in Lebanon
veh	vehicle(s)
VIP	very important person (tpt)
V(/S)TOL	vertical (/short) take-off and landing
Yug	Yugoslav

The source for material in the comparative study is the International Institute of Strategic Studies, London.

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