ESTABLISHMENT OF CSIR LABORATORIES - AN ANALYSIS OF FACTORS

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CERTIFICATE

This is to certify that the thesis entitled ESTABLISHMENT OF CSIR LABORATORIES - AN ANALYSIS OF FACTORS and submitted by N.R. RAJAGOPAL ID NO. 87 PHXF 401 for award of Ph. D Degree of the Institute, embodies original work done by him under my supervision.

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Dedicated
to
my parents for having introduced me
to Science

and my wife for having supported me
in all my endeavours

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(N.R. RAJAGOPAL)

Abbreviations

COUNCIL's ESTABLISHMENTS

CBRI	Central Building Research Institute, Roorkee
CCMB	Centre for Cellular & Molecular Biology, Hyderabad
CDRI	Central Drug Research Institute, Lucknow
CECRI	Central Electrochemical Research Institute, Karaikudi
CEERI	Central Electronics Engineering Research Institute, Pilani
CFB	CSIR Centre for Biochemicals, Delhi
CFRI	Central Fuel Research Institute, Jealgora
CFTRI	Central Food Technological Research Institute, Mysore
CGCRI	Central Glass & Ceramic Research Institute, Calcutta
CIMAP	Central Institute of Medicinal and Aromatic Plants, Lucknow
CLRI	Central Leather Research Institute, Madras
CMERI	Central Mechanical Engineering Research Institute, Durgapur
CMRS	Central Mining Research Station, Dhanbad
CRRI	Central Road Research Institute, New Delhi
CSIO	Central Scientific Instruments Organisation, Chandigarh
CSIR-C-M	CSIR Complex, Madras
CSIR-CX-PAL	CSIR Complex, Palampur
CSMCRI	Central Salt & Marine Chemicals Research Institute, Bhavnagar
IICB	Indian Institute of Chemical Biology, Calcutta
IICT	Indian Institute of Chemical Technology, Hyderabad

IIP	Indian Institute of Petroleum, Dehradun
IMTECH	Institute of Microbial Technology, Chandigarh
INSDOC	Indian National Scientific Documentation Centre, New Delhi
ITRC	Industrial Toxicology Research Centre, Lucknow
NAL	National Aeronautical Laboratory, Bangalore
NBRI	National Botanical Research Institute, Lucknow
NCL	National Chemical Laboratory, Pune
NEERI	National Envirnomental Engineering Research Institute, Nagpur
NGRI	National Geophysical Research Institute, Hyderabad
NIO	National Institute of Oceanography, Dona Paula (Goa)
NISTADS	National Institute of Science Technology and Development Studies, New Delhi
NML	National Metallurgical Laboratory, Jamshedpur
NPL	National Physical Laboratory, New Delhi
PID	Publications & Information Directorate, New Delhi
RRL-BHO	Regional Research Laboratory, Bhopal
RRL-BHU	Regional Research Laboratory, Bhubaneswar
RRL-JMU	Regional Research Laboratory, Jammu
RRL-JOR	Regional Research Laboratory, Jorhat
RRL-TRI	Regional Research Laboratory, Thiruvananthapuram
SERC-G	Structural Engineering Research Centre, Ghaziabad
SERC-M	Structural Engineering Research Centre, Madras

ESTABLISHMENT OF CSIR LABORATORIES - AN ANALYSIS OF FACTORS

Synopsis

This thesis is on the analysis of factors responsible for and contributing to the establishment of CSIR Laboratories - in particular, a selected few that represent the entire gamut of the activities of CSIR. The factors, not always apparent,have been derived or drawn out of the historical processes and deliberations that culminated in decisions concerning the establishment of those laboratories. The principal objective here is to sift the factors - internal and external to the system - from published documents, official records and files, analyze them and establish the main reasons that were responsible for the creation of the laboratories. The analysis is partly historical in approach and traces the development of the factors being investigated. Whenever necessary or possible, the views of senior scientists closely connected with the functioning of the laboratories for a number of years are also recorded.

One of the important achievements of this analysis is the documentation of the factors for **all** the laboratories, based on available data and personal knowledge. It is possible to go deeper into this aspect and identify all the probable factors for all the CSIR laboratories. On the basis of the investigation undertaken, a proforma for the proposal of establishment of an R&D laboratory, similar to a national laboratory of CSIR, has been designed and appended.

The thesis is divided into the following eight (8) chapters:

Chapter I is introductory in nature, dealing with the genesis of CSIR, the Hill Report, the different phases of growth of laboratories setting their objectives and broadly asking the question why and how were the laboratories established.

Chapter II looks at the earlier literature - available on the subject and focuses on the need for undertaking the study under discussion.

In Chapter III, the objectives of the thesis are spelt out. Some preliminary statements regarding the nature of the factors being internal to the system and/or external (brought to bear on the system) are made. Again the NEED for investigating these background criteria of establishment of laboratories is sought to be stressed.

Chapter IV describes the methodology followed in sifting and analyzing data and drawing conclusions thereon. Also stated here is the fact that there are six laboratories - three old and three young - and an experimental station, subjected to exhaustive analysis.

The circumstances of establishment - historical account based on past documentation - of the six laboratories, taken in chronological order, are narrated in **Chapter V.** The critical nature of some of the circumstances (actually becoming later important factors of establishment) is adequately emphasized, whenever possible.

The data thus collected are analyzed in **Chapter VI**. The factors responsible for the establishment of these six laboratories and the : ation are also identified here. In support of the identification, information available in Review Committee reports, expert comments and excerpts of official communications (normally not available for publication) are quoted.

Chapter VII makes a slight departure and holds spotlight on the derived points. Here an attempt is made to answer the rather difficult question how can one evaluate the performance of a national laboratory. The industrial scenes before and after the establishment of the laboratories, criteria (ABCD analysis) for measurement of the Research Output (RO) of the six laboratories in view and the contribution of CSIR in general to industry during the Seventh Plan (1985-90) are discussed here, duly supported by graphs and tables.

The last chapter (**Chapter VIII**) deals with conclusions. Beginning with a historical perspective of Indian Science, it proceeds to look at the rather tenuous relationship between research and industry in India. A comparison is made of what happened in the USA with the course of events here. A subtle difference in the terms: 'research-for-industry 'and' industrial research' is noted. Success stories are discussed and failures (due to extra-scientific/technological reasons) are analyzed. The present patterns of organization of industrial research in some other countries as given in statements by the Heads of Scientific Agencies of those countries, are delineated. What is the future of CSIR laboratories and how is it being planned are other questions considered.

CONTENTS

CHAPTER I

INTRODUCTION

This thesis is on the factors responsible for the establishment of some of the national laboratories of the Council of Scientific & Industrial Research (CSIR), considered one of the premier scientific agencies of India. The investigation is based on the analysis of published and unpublished (but official) records relating to their establishment.

In this introductory chapter, it is proposed to trace the historical development of CSIR, the role the then government played, the chronology of the establishment of the laboratories, and locate the obvious, but not necessarily the entire, factors which paved the way for their coming into being. A statement regarding the objectives of laboratories established is also made because as elaborated in the concerned chapters to follow, further examination of the objectives leads to several interesting related dimensions of the founding of these laboratories.

Genesis of CSIR

"But these institutes have to gradually affect our minds- not only the minds of those who work here, but the minds of others too and more especially the minds of the rising generation, so that the nation may grow up imbibing the spirit of Science and be prepared to accept a new truth--------" . Thus spoke Jawahar Lal Nehru on the occasion of the opening of the Central Fuel Research Institute, (CFRI), Jealgora, on 22 April 1950 (Baldev Singh Ed.).

This was the third national laboratory of the Council of Scientific and Industrial Research, or CSIR as it is called,to go on stream that year, the other two being the National Chemical and the National Physical Laboratories at Pune and New Delhi respectively.

Three more - the National Metallurgical Laboratory, (NML), at Jamshedpur, the Central Food Technological Research Institute, (CFTRI), at Mysore and the Central Glass and Ceramic Research Institute (CGCRI) at Calcutta - were established in 1950. By the end of 1954, more or less corresponding to the end of the first five year plan of the country, there would have been established under CSIR fourteen (14) National Laboratories, spread over India.

These laboratories were to undertake research and development in areas of direct relevance to industrial development of the country. They had specific objectives to fulfil. Nehru dreamt of "large numbers of young men and women coming into these laboratories and research institutes and working with zeal and enthusiasm for the advancement of science in India and through science the advancement of the Indian people" (Baldev Singh Ed.). Why were these laboratories created?

The origin of CSIR provides the authentic backdrop of the raison 'detre' of the creation of these laboratories. The Indian Industrial Commission urged the Government of India in 1918 to promote applied research. In 1936, a Bureau for Industrial Intelligence and Research was set up. This Bureau gave place to the formation of the Board of Scientific and Industrial Research, to advise the government on industrial research, and development of Industry. Dr. Shanti Swarup Bhatnagar was appointed the Director, Scientific and Industrial Research. Later this Board was converted by the government to function as an Advisory Board of a new organization entitled the Council of Scientific and Industrial Research.

Thus it was in 1942 that CSIR came to be established as a registered society under the Registration of Societies Act (Act XXI of 1860). The principal objective of CSIR was "the promotion guidance and coordination of scientific and industrial research in India and the utilization of the results of researches towards the development of industries in the country" (25 years of CSIR).

In the summer of 1943, the Royal Society was invited by the Secretary of State for India to send a representative to India to advise on "-----the organization of scientific and industrial research as part of the Indian post-war construction plan, and its coordination with the corresponding activities here". (Hill, A.V.).

Hill Report

Prof. Hill, who came to India in November 1943, visited a large number of scientific institutions and on the basis of his own understanding and the discussions he had with Indian scientists presented a report to the Government of India. One of the important points emphasized in the report related to the lack or absence of liaison between scientists of India and their counterparts in England and the need for training of young Indian researchers in England. The report also dealt with surveys and agricultural, medical and industrial research in India. The portion pertaining to industrial research under the government merits consideration.

It was more or less assumed that India should follow the same path that Britain took for furtherance of her scientific activities. It was stated, "the example of the Department of Scientific and Industrial Research in the United Kingdom which, founded in 1916, has attained a very important position and will have an increasing influence as time goes on, indicates the direction in which industrial research should develop in India" (Hill A.V.). Thus were to be born in India the national laboratories for Physics, Chemistry, Metallurgy, Fuel research and Glass research, almost as the look-alikes of those for the same disciplines in the UK. Food processing, ship design, aeronautics, radio science, building and road were the other subjects talked about. Cooperative Research Associations, as were existing in England, were also recommended. A separate mention was also made of the need for special consideration by DSIR to the encouragement of the scientific instruments and equipment industry.

Two Phases

Following the Hill Report, a Research Planning Committee under the chairmanship of Sir R.K. Shanmukham Chetty made recommendations for the development of scientific and industrial research. It was realized that one of the major purposes for which CSIR was founded was "the establishment, maintenance and management of laboratories, workshops, institutes and organisations to further scientific and Industrial research and to utilize and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use to Indian industries" (CSIR Rules). The following table (CSIR Handbook) shows the growth of the laboratories, till 1966:

Year	No. of labs/Institutions	Subjects
1950	6	Chemistry, Physics, Fuel Research Glass & Ceramics, Food Technology, Metallury.
1951	3	Drug, (Publications, Documentation)
1952	1	Road
1953	5	Electrochemistry, Leather, Building, Botany, Electronics Engineering Research.
1954	4+1*	Mining Research, Salt & Marine Chemicals, Experimental Medicine, Regional Research Laboratory, Hyderabad (RRL (H), Birla Museum
1957	1	RRL Jammu
1958	2	Mechanical Engineering, Public Health Engineering
1959	5	Medicinal Plants, Aeronautics, Regional Research Laboratory (Jorhat) Petroleum, Scientific Instrumets
1961	1	Geophysics
1962	1*	Visvesvarya Museum
1964	1	Regional Research Laboratory, Bhubaneswar
1965	2	Structural Engineering, Industrial Toxicology
1966	1	Oceanography

(* The Birla and the Visvesvaraya Museums are no longer under CSIR)

At about the same time, a number of Industrial Research Associations (IRAs) were also founded and placed under CSIR. All of them have now been transferred to the Ministry of Industries of the Government of India. The pattern of establishment of IRAs was -

1947	1	Textile Industry (Ahmedabad)
1950	1	Silk & Art Silk
1951	1	Textile Research (South India)
1954	1	Textile Industry (Bombay)
1959	1	Paint
1962	2	Plywood, Cement
1963	1	Wool
1964	1	Tea
1966	2	Jute, Rubber

In sum, as far as the national laboratories are concerned, two distinct phases of creation of laboratories are observed.

Phase I	between 1950 and 1966 (17 year period)	-	32 labs/institutions and 1 Industrial Research Association
Phase II	between 1966 and 1985 (20 year period)	-	7 labs/institutions and 1 Industrial Research Association

Phase II saw the emergence of the following laboratories:

1965/66	1 Structural Engineering Research Centre, Madras (SERC(M)
1981	1 Centre for Cellular & Molecular Biology (CCMB) Hyderabad
1976/81	2 RRLs (Trivandrum, Bhopal)
1980	1 National Institute of Science Technology & Development Studies (NISTADS), New Delhi
1984	1 Institute of Microbial Technology (IMTECH) Chandigarh
	1 CSIR Complex, Palampur

It is interesting to note that during the first phase, spurts in the growth of laboratories were noted on three occasions, - first in 1950 (6 labs), secondly in 1953 (5 labs) and finally in 1959 (5 labs). It may be coincidental but worth noting that the first 11 laboratories came up during the first plan period (1950-55) and the second set of 5 laboratories during the second plan period between 1955 and 1960. The first Plan envisaged the creation of basic infrastructure. It was known ... "the Five Year Plan is essentially a plan of preparation for laying the foundation for more rapid development in the future." Outlining the measures for increasing industrial productivity, the Plan noted," ..... we should stress the need for industrial and scientific research. The Government has a part to play in this field and it is satisfactory that the Council of Scientific and Industrial Research have been expanding steadily to cover a wide field." (The First Five Year Plan).

As compared to these spurts and initial busy periods of establishment, the second phase was a period of steady growth. Only seven laboratories came up during these 20 years. In fact three of them (SERC, CCMB and NISTADS) sprang up from existing institutions and one (at Palampur) was a loosely got up complex of existing divisions of laboratories needing an outlet for extending their activities in the region concerned. Of the remaining three, two were regional laboratories (at Trivandrum and Bhopal). Here then is a pointer to the fact that in the second phase, the factors responsible for the establishment of laboratories were different. One of the factors can possibly be traced to the recommendations of the different Reviewing Committees that went into the working of CSIR. There were four of them:

The first Reviewing Committee, under the chairmanship of Sir Ardeshir Dalal gave its report in 1949. No laboratory was in existence then.

The second Reviewing Committee headed by Sir Alfred C. Egerton, submitted its report in 1954. By then, 14 laboratories and two institutions (PID,INSDOC) had come to be established.

The third Reviewing Committee headed by Sir A. Ramaswamy Mudaliar finalized its report by 1964. There were now 30 constituents under CSIR. Afterwards 10 laboratories/institutions came to be established by CSIR.

The fourth Reviewing Committee known as the Abid Husain Committee (after its Chairman Shri Abid Husain) submitted its report in 1986.

Laboratories and Objectives

Another factor can be inferred from the broad or pervasive nature of aims and objectives of the laboratories when they were established and how they underwent changes.

At the time of the inauguration of the National Physical Laboratory (NPL) in 1950, Dr. S.S. Bhatnagar stated "the work of the laboratory would be carried in the following nine disciplines (i) weights and measures (ii) applied mechanics and materials (iii) heat and power (iv) optics (v) electricity (vi) electronics and sound (vii) building and housing research (viii) hydraulic research and (ix) analytical chemistry (NPL inauguration brochure). Of the above, building research and hydraulic research were left out since separate laboratories were either existing or proposed for these disciplines.

Dr. K.S. Krishnan, its first Director hoped then that NPL would be "something like the American National Bureau of Standards".

Later NPL was entrusted with the maintenance of three basic standards of mass, length and time. It had also the responsibility for setting and maintenance of standards in electricity, temperature, photometry and radiation (NPL Review 1962).

In 1975 at the time of the celebration of its silver jubilee, it was decided "the objective of NPL is to strengthen and advance physics - oriented research and technology and to assist in their effective utilization for the public benefit". Custody, development and maintenance of the national standards etc. was one of the ways of achieving the objective (NPL Silver Jubilee Booklet).

In 1989, the laboratory carried out research and development activities in the areas of (i) measurement standards and calibration (ii) electronics and engineering materials (iii) radio and atmospheric physics (iv) cryogenics and superconductivity (v) applied physics projects viz. thin film optical coatings, xeroradiography, high pressure metal forming, high power ultrasonic systems for oceanographic studies and (vi) theoretical studies in condensed matter physics (CSIR Handbook 1989).

In 1950, at the time of inauguration of NCL, Nehru set forth its objectives as " the advancement of knowledge and the application of chemical science for the good of the people". (NCL Silver Jubilee Volume).

In 1975 at the time of its silver jubilee function , the same objectives were in force.

Even in 1989, NCL, as a discipline oriented laboratory was devoted to the advancement of chemical science and engineering.

In 1954 was established the Central Salt & Marine Chemicals Research Institute (CSMCRI), at Bhavnagar. Some of the scientists of NCL working in that area moved over to CSMCRI.

Let us take a look at the objectives of the newer laboratories. The main objectives of NIO, established in 1966, are: to explore both living and non-living resources in the seas around India and to develop technology for the exploitation of resources from the sea. The Institute aims to be a focal point for oceanographic data and information pertaining to the Indian Ocean. (CSIR Handbook 1989).

In 1984 was established IMTECH. It is the youngest among the CSIR constituents and has been set up with a view to carrying out research in the frontier area of microbial technology and genetic engineering (CSIR Handbook 1989).

The statements regarding the objectives of the old and new laboratories, as originally set forth and revised (or maintained as such) from time to time, point to the need of reorientation and consequent readjustment of functioning of these laboratories, depending on changing times, changing emphasis on the kind of output expected etc. but most certainly on the progress of Science itself. How did the laboratories come to be established and how were their objectives defined, have they been realized generally and have any more readjustments been necessary, are matters that need be investigated. The results of these investigations are discussed in another chapter. In the following Chapter, however, we are examining the availability of published literature on this and similar lines of inquiry.

CHAPTER II

EARLIER LITERATURE

The ways in which organizations get built makes an interesting subject of study. Sometimes the processes appear quite natural, sometimes contrived and often there seems to be some inner and possibly invisible logic which seems to build up the organization. It appears as though organizations spring up, grow and decay with a logic of their own and independent of human will. Studies on building up organizations devoted to research and development are not many. Growth of scientific organizations in the UK, the USA and France had been investigated but hardly is there any literature on organizational build up in developing countries.

The need to study and understand the organizational growth of the S&T set up in developing countries becomes obvious when one considers the enormous potential S&T offers for development and growth and the increasing faith of the political leadership of these countries on S&T as a tool for development and improvement of the quality of the lives of their peoples. Apart from Environment, which again has a large S&T component, there have not been many subjects other than S&T, that have been discussed in international meets. Here, perhaps the experience of a country like India, which has a long tradition of Science of its own and practises science as per Western norms, will be of practical significance.

Amongst the studies made in the United States two are important. One is the Organization of Industrial Scientific Research (Kenneth Mees and John A Leermakers) and the other is 'The Uneasy Alliance: Managing the Productivity-Technology Dilemma', (Ed. Kim Clark et. al.)

Mees and Leermakers give an account of the history and development of industrial research, the general principle of its conduct and an analysis of the methods actually used for the organization and operation of industrial research laboratories.
They deal in a general way with government laboratories, associations for industrial research, technological research institutes and some large industrial laboratories.

An indication as to the origin and the need of establishment of some industrial research laboratories in the American context is given. A quick overview of the involvement of governments of other countries (including, surprisingly enough, India) in setting up laboratories is provided, but no specific investigation on the whys and hows of the processes of such establishments has been undertaken.

A more analytical account is available in Uneasy Alliance. "This was the product of a remarkable Harvard Business School research colloquium that brought together over fifty experts - both corporate executives and academics. The participants assessed the roots of the problem and the impact of different managerial practices on productivity and innovation from widely different perspectives. Theoreticians and practitioners answered each other's arguments in lively discussions", the highlights of which were included in this volume. What is of relevance is Nathaniel Rosenberg's paper "The Commercial Exploitation of Science by American Industry" followed by Alfred D. Chandler Jr's commentary "From Industrial Laboratories to Departments of Research and Development". The commentary looked beyond the creation of the industrial laboratory - the historical phase described in Rosenberg's paper - to the subsequent building of a larger organization responsible for systematic development of products and processes. (The Uneasy Alliance .... Ed. Kim Clark et. al.).

Management of Research and Development has been the subject of several seminars, conferences and investigations in the United States of America. A number of books have been published. These generally deal with situations peculiar to research laboratories in existence and are in no way near the question that has been posed here.

A 1982 publication of the University of Manchester looks at the problem of a collaborative research strategy using major industrial laboratory facilities in the UK. Possible methods of funding are considered and likely areas of research identified. Other than these there does not appear to be any study or investigation in regard to developing countries, particularly India.

There is, therefore, an apparent need to undertake a study of the R&D laboratories, covering some of these points, if one wants to understand the Indian conditions. What should be the objectives of such a study and why should such objectives be considered are matters dealt with in Chapter III.

CHAPTER III

OBJECTIVES

The objectives of this investigation are:

(1) to examine critically the circumstances that attended the establishment of six CSIR laboratories,

(2) to investigate the internal and external factors responsible for their establishment,

(3) to analyze the objectives with which they were set up, and

(4) to identify the reasons for the functioning and growth of these laboratories in fulfilment of their objectives.

It may not be far from true to say that there were several factors responsible for the establishment of these laboratories, and not all of them were scientific or technical in nature. They could only be derived or inferred if one went deep into the origins of these institutions. The initial stages were quite different . Possibly the beginnings of CSIR were conditioned by factors that were beyond the scope of analysis.It was the policy then to set up a number of establishments in different fields more in the spirit of creating the basic infrastructure needed for a poor country to make the wheels of change move in the direction of progress by the use of Science and Technology. As has been outlined earlier, (Hill A.V.) the British model in general was followed. The possible reasons could be:

- the country was still suffering from the hangover of colonialism
- it was safe to start with a known process of reconstruction, and
- almost the entire intelligentsia vested with the responsibility of starting up research institutions was trained in the West, particularly in England.

Yet, more than all these, the one factor that gave the much-needed momentum to the creation of these laboratories was the coming together of Nehru and Bhatnagar giving rise to the Nehru-Bhatnagar effect. (The CSIR Saga). There does not appear, therefore, any further need to emphasise the fact that a multiplicity of factors- often interacting with each other- played significant roles in the coming into being of these laboratories.

For purposes of analysis, the factors of establishment can be classified into two broad types- the internal and the external.

Factors	
Internal	External
Scientific	Political
Technological	Economic
Industrial	(Plan priorities, user involvement)
Compulsions	Societal
	Strategic

These factors are environment-controlled and hence are dependent on internal and external stresses. The internal environment is internal to the system and influences the factors that are outlined here. The strategic factors are external to the system and in some cases external to the country as a whole.

Although the founding of the research laboratories can be traced to factors of either of the two categories,in a few cases, entirely different criteria operate. These are overriding factors that necessitate the formation of the laboratory. The availability of a basic structure which is taken over by the organization for conversion later into a national laboratory is one example of this type.

Whatever may be the factors responsible for establishing these laboratories, availability of certain basic needs in terms of scientific manpower, equipment and physical facilities are called for before a laboratory comes up. An analysis of all these factors is an objective of this investigation.

Other Objectives

Another objective not explicitly stated is the evaluation of the performance of laboratories in terms of their having fulfilled the objectives with which they were set up. This is a very vast subject as evaluation of research takes different forms.

There have been arguments for and against known attempts at evaluation of performance of research laboratories. Yet there seems to be agreement that it takes quite some time for the laboratories to show results and hence the evaluation can be thought of only after they have been in existence for 3,4 or more years depending on what is sought be evaluated. In our present analysis that condition is well satisfied because the laboratories we propose to study have been in existence for at least ten years.

At this stage it is pertinent to ask: is there a **need** for this kind of a study. There is no one answer to this query. Consider first the stage of development of the country as a whole. Most of the CSIR laboratories were set up over a quarter of a century before. The extent and coverage of disciplines may not be there in other countries and more so in developing countries. It is therefore timely to attempt an evaluation of the factors that led to their establishment. As in other cases, our experience will be valuable.

Further UNIDO set forth some reasons for setting up industrial research institutes in developing countries. One of these documents (Monograph on Industrial Development UNIDO) envisaged the involvement of the institute in basic research more at an advanced stage of its development, rather than in the early stages. Adaptive work was supposed to occupy a major portion of the time and resources in a laboratory in its early period. At least in the case of CSIR laboratories this has not been true. A completely different set of criteria determined the nature of work of these laboratories.

After the establishment of laboratories vast and rapid changes have been witnessed. Science has undergone change. Inter-disciplinary work is the mainstay of an industrial research laboratory. The basis of starting an industrial research laboratory has to be the needs at a given time; yet the infrastructure, equipment, information etc. have to be built-up. Was this the case?

In trying to answer these questions particularly with reference to the six CSIR laboratories in view, a certain amount of past records had to be studied. How was this done, and what was the methodology used are matters described in the next chapter.

CHAPTER IV

METHODOLOGY

The establishment of a research laboratory has followed a certain pattern. This consists of identifying the needs, setting up an expert committee to go into these needs and obtaining a report on the type of laboratory to be set up, having this report considered at the decision making level and then entrusting the actual establishment to a specialist or a group of specialists.

With minor variations, this practice has been followed in most of the cases. Naturally, therefore, there are various reports and notes submitted to the Board of Scientific and Industrial Research (BSIR) outlining the various proposals.

In recent times, the Governing Body (GB) of CSIR had replaced BSIR as the apex level authority to decide and approve. The principal methodology of investigating the factors of establishment of laboratories consists of analyzing the information and data contained in these reports and proceedings of apex level meetings.

Over the years some of the laboratories have grown in size and expanded their scope and capability. When such expansion called for additional inputs of some value, these had also to be considered by GB.

In certain cases, such expansion necessitated the acquisition of special characters by a few laboratories and they had to undergo changes in their titles. Some examples are:

Old name and year of establishment	New name and year of change
National Botanic Garden, Lucknow, 1953	National Botanical Research Institute, Lucknow, 1978
Central Public Health Engg. Research Institute, Nagpur 1959	National Environmental Engg. Research Institute, Nagpur, 1974
Indian Institute of Biochemistry and Experimental Medicine, Calcutta, 1956	Indian Institute of Chemical Biology, Calcutta 1981
Regional Research Laboratory, Hyderabad, 1956	Indian Institute of Chemical Technology, Hyderabad 1989

In each case adequate reasons were given for seeking the name change. They do give a clue as to how and why laboratories get started.

Then there are field stations of laboratories set up in different locations. There are reasons why they came up. These proposals were also considered by the apex bodies.

The source materials for collection of data and gathering of information comprise

- reports of the Planning Committees of laboratories
- recommendations of other expert committees
- proceedings of BSIR, GB, etc.
- archival information sifted from journals of the period.
- annual and periodical reports of the laboratories
- lectures and writings of contemporary scientists, etc.

The laboratories taken up for consideration for this study are

Old	**Young**
>25 years	<25 years
NPL	RRL,Trivandrum
NCL	RRL, Bhopal
CLRI	CCMB

One Experimental Station considered is the Tower Testing Research Station (TTRS) of SERC-M.

In the case of each laboratory a profile was prepared. This gives the present status in brief.

In the case of CLRI a rough cost-benefit analysis was attempted, assuming what would happen if there were no CLRI and the Indian Leather Industry now decided to set up an industrial research laboratory for leather.

Chapter V, to follow, deals with the circumstances of establishment of these laboratories. This is more in the nature of a historical analysis based on either the documents available in the printed form or records available in official files and personal knowledge of men, matters and events.

CHAPTER V

CIRCUMSTANCES OF ESTABLISHMENT

In this chapter the circumstances leading to the establishment of three laboratories in the first phase of founding of CSIR (i.e. NPL NCL and CLRI) and three laboratories in the last phase (RRLs Trivandrum and Bhopal and CCMB) are being analyzed.

Why these laboratories?

We take these laboratories for analysis because

NPL NCL	first two in the chain, for basic disciplines,forming the core of CSIR organization (Physics, Chemistry)
CLRI	also in the first eleven proposed - a commodity - oriented R&D laboratory
RRLs	laboratories proposed for regional development, in collaboration with respective State Governments
CCMB	basically a laboratory intended to do fundamental research in modern biology
and TTRS	an experimental station of a laboratory

It has been pointed out that in 1945 the RK Shanmukham Chetty Committee recommended the establishment of a chain of national laboratories including the Physical (NPL) and the Chemical Laboratories (NCL). An estimated cost of Rs. 40 lakh for each was mentioned. The report of the Chetty Committee did not go unnoticed; in fact it was subjected to critical appraisal. It is in this context that the foundation stones of NPL and NCL were laid in April 1947.

NPL

The historical background of the establishment of NPL in Delhi (Shiv Viswanathan) makes interesting reading. Bhatnagar, who was later to oversee the functions of BSIR, had in 1941, proposed the establishment of NPL and NCL. War necessitated the shifting of BSIR from Calcutta to Delhi. Once in Delhi, things moved faster. CSIR came into being in 1942 and was naturally vested with the responsibility of bringing the laboratories in operation.

The Governing Body of CSIR had approved in 1943 the setting up of two committees for the purpose of drawing up plans and estimates for the National Physical Laboratory and the National Chemical Laboratory.

A piece of land (66 acres) near what was then the Imperial Agricultural Research Institute (now known as the Indian Agricultural Research Institute, IARI, for short) at New Delhi was made available by the Government for NPL.

A Planning Committee for NPL was formed and after a series of meetings the plan for NPL was approved in December 1945. It was later in January 1950 that NPL was formally inaugurated by Sardar Vallabhbhai Patel, Deputy Prime Minister of India.

In a paper outlining the growth of CSIR during the last forty eight years, it is pointed out that "in the area of physical sciences the pride of place is taken by the National Physical Laboratory which has the unique function of maintaining primary standards of physical measurement for the country at the highest accuracy" (Mitra A.P.). Before the establishment of NPL, instruments had to be sent to the UK and the USA for calibration. India is now self-sufficient in this area.

NPL's first major role was in providing the technical expertise needed for the introduction of the metric system of weights and measures in the country. The Weights and Measures Act came into force in 1956. The laboratory set up divisions to work on primary standards and the facilities for calibration work against these standards.

NPL, however, was not intended merely to be a standards laboratory. The Planning Committee of NPL felt the laboratory should undertake researches on applied physics and fundamental scientific research arising out of the work related to metrology and applied physics. Today the laboratory can claim excellence in materials science, radio and space science and low temperature physics. A major strength of the materials group was the establishment of a first rate material characterization facility for which a large part of equipment was constructed in the laboratory itself.

A unit called the Development -cum-Production of Electronic Components was later to manifest itself as the public sector enterprise called the Central Electronics Ltd., (CEL). It is the only public sector undertaking emanating from CSIR efforts.

A strong radio- science group led by Dr. A.P. Mitra undertook major programmes such as the International Geophysical Year (1958- 59), the International Quiet Sun Year (1964-65) and the

Indian Middle Atmosphere Programme (1985-90). NPL is now poised to participate effectively in the International Geosphere-Biosphere (Global Change) Programme. A profile of the Laboratory is appended (appendix V).

NCL

An area of 475 acres at Pune near the University was earmarked for the founding of NCL. The location followed a condition by the Sir JD Tata Trust that the laboratory be set up either in Bombay or in a place not far from the Presidency. The foundation stone of the NCL building was laid in February 1947 by Shri BJ Kher, the then Chief Minister of Bombay and the Laboratory was declared open by Prime Minister Nehru on 3 January 1950.

The work of NCL, during the fifties, was carried out in seven Divisions dealing with Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Biochemistry, Plastics & Polymers, Chemical Engineering and Survey & Information. In the early stages the tendency was to emphasize on short term research activities. Later as revealed by a 1954 Report" it is now becoming possible to lay more stress on long range applied problems and on the vital importance of carrying out fundamental research in all the Divisions of the laboratory".

In 1971 a pesticides planning group of the National Committee of Science and Technology was set up. The status report was prepared by NCL which also acted as a laboratory to develop indigenous technologies for the preparation of a number of agrochemicals.

Most of them were successfully transferred to the industry. Another successful programme of NCL has been the development of several types of catalysts for the petrochemical industries.

Polymer Science is another area of proven competence.(A profile of NCL is in Appendix V)

For purposes of comparison, a table showing objectives and divisions of NCL and NPL is given below:

OBJECTIVES AND DIVISIONS OF THE LABORATORIES

Laboratory	OBJECTIVES			DIVISIONS	
	At the time of est.		At present (1992)	At the time of est.	At present (1992)
NCL	(1950)	Advancement of knowledge and the application of chemical science for the good of the people	Advancement of Chemical science and engineering (Safer Chemistry for better environment; new feedstock to reduce dependence on oil; biology/ chemistry interface; new and advanced materials).	Inorganic/Organic, Physical, Chemistry; Biochemistry; Plastics & Polymers; Chemical Engineering; Survey & Information.	Biochemical Sciences; Plant Tissue Culture; Organic Chemistry; Synthesis, Technology; Catalysis; Inorganic Chemistry; Materials Chemistry; Polymer Chemistry; Physical Chemistry; Process Development; Chemical Engineering; Technical Services.
NPL	(1950)	Something like the American National Bureau of Standards (Dr. K.S. Krishnan)	R&D in the areas of measurement standards and calibration; electronics and engineering materials; radio and atmospheric physics; cryogenics and superconductivity; applied physics and theoretical studies in condensed matter physics	Weights and measures; Applied mechanics and materials. Heat and power; Optics; Electricity, Electronics and sound; Building and housing research; Hydraulic research and analytical chemistry (Radio Science was added later)	Physico-mechanical and Electrical Standards; Materials; Characterization; Condensed matter Physics; Radio Science; Technical Infrastructure
	(1962)	Maintenance of three basic standards of mass, length and time.			
	(1965)	Applied research in all aspects with a view to helping industries; basic research; developmental testing; maintenance of basic and derived standards			
	(1975)	Strengthen and advance physics-oriented research and technology and assist in their effective utilization for the benefit of the public.			

CLRI

That a Central Leather Research Institute (CLRI) be set up as a national laboratory was already a recommendation of the Board of Scientific & Industrial Research (BSIR). As its plans were getting ready and being examined by the Leather Research Committee (LRC), certain specific points also came up. In its 17th meeting held on 16.9.1946, BSIR approved of the recommendation of LRC (14.2.1946) that "a properly equipped tannery would be an essential adjunct to the proposed CLRI to carry out investigations on problems relating to practical leather manufacture on a semicommerical scale". It was also at this meeting that funds were recommended for the starting of the Leather Technology Institute of the University of Madras.

One of the principal reasons assigned for the decision on the establishment of CLRI was to ensure that the benefits of new discoveries in science and technology reached the Indian Leather Industry and helped its development on modern lines. This recommendation of LRC was also strongly supported by the Industrial Research Planning Committee.

Right from the time the idea of founding a CLRI was accepted, LRC, presided over by the father figure of Prof. BM Das had been planning and recommending research schemes to be taken up by different leather technology institutions in the country, chief of them being the Bengal Tanning Institute, Calcutta, of which Das was the then Superintendent. Improvement in flaying conditions, indigenous vegetable tanning materials (babul, avaram etc.) and improvement of hides and skins were the subjects under consideration.

B.M Das was to retire on 1.4.1948 and the members of LRC in their meeting on 17.2.1948 recommended he be retained as Chairman, even after superannuation.

Having accepted Madras as the location of the Institute the selection of site presented a few difficulties. These were resolved by the then Chief Minister of Madras Shri P.S. Kumaraswamy Raja. The Government of Madras gifted a site of 84 acres in the Guindy area. The cost of reclaiming the site and diverting the road running through it (Rs. 3.07 lakh in all) was borne by the Madras Government.

Dr. Shyam Prasad Mukerjee the then Minister of Industries and Supplies of the Government of India, laid the foundation stone of the Institute on 24.4.48. A Local Planning Committee with Dr. A. Lakshmanaswamy Mudaliar (Vice-Chancellor of the University of Madras) as the Chairman was set up.

Shri K. Seshachalam Chowdhary was appointed the Planning Officer on 26.11.48. His unfortunate demise on 10 January 1951 and the equally unfortunate passing away of his successor Dr. A.L. Sundara Rao on September 18, 1951, interrupted the progress of the building construction. BM Das was appointed the Officer on Special Duty on 26 September 1951 and the planning, construction, and equipping of the Institute was completed.

(BM Das was appointed the Director of CLRI on 16 January 1953.)

LRC, obviously because it was presided over by the head of CLRI, took keen interest in the planning and establishment of CLRI at Madras.A joint meeting of LRC and the Planning Committee of CLRI presided over by BM Das was held on 16.1.1953 and the short term and long term programmes proposed for CLRI were exposed before the members. After their deliberations, the programmes were approved by BSIR in its 30th meeting held on 10.3.1953. It is interesting to note that the joint meeting also discussed the proposals of the Madras Government's Committee on leather and leather goods industry.

LRC continued to function under the chairmanship of BM Das, Director CLRI up to 1956. There was no mention of its existence in the proceedings of the 37th meeting of BSIR held on 18.9.1956.

At the time CLRI came into being the leather industry in India was technologically in a primitive stage. Huge quantities of raw hides and skins used to be exported to the west. They were imported in India as finished leathers and products at heavy cost. Almost the first item on the agenda of CLRI was to indigenize the processing of various kinds of leather and disseminate this knowledge to the tanneries steeped in tradition and bereft of any scientific input in their operation.A team of well trained leather technologists took up the challenge of research and development in the multidisciplinary area. Fortunately CLRI had a continuous supply of leather technologists trained in the Madras University just adjacent to the institute. This was part of the grand design that the Vice Chancellor Dr. A.L. Mudaliar had. He had a vision of transforming the entire location into a scientific and technological complex. Already the Madras Engineering College and the AC College of technology were there. CLRI had now come into being. Highways Research Laboratory and IIT would be added later, to complete the establishment of a higher - technological - institutions - complex in close proximity to each other.

As a result of the dedicated efforts of the early workers, transformation in the leather industry was visible. The tanners were quick to realize the importance of processing of leathers internally and sending them out in semi-finished or finished condition. By the end of the fifties CLRI had established itself as the principal technical adviser to many a tannery in the country.

In the sixties the industry catered to the domestic market with production based mostly in the small scale or cottage sector. Raw hides and skins and a small quantity of semi finished leather were exported. In the seventies the industry was concerned with the export of semi finished leather. In the early eighties export of finished leather started. This was the time that modernisation of tanneries occurred.

The late eighties saw another change -- the phenomenal increase in the export of leather goods and other products.

Leather is now the 4th largest commodity export from India. Leather exports are expected to cross a figure of Rs.3500 crore per annum by the end of this year (1992).

Not a little of this is due to the sustained efforts of CLRI. A highly technology oriented unit having support of well equipped laboratory research at Madras acting as the nerve centre for similar but smaller units in the important leather producing regions of the country (Calcutta, Jalandhar, Kanpur, Rajkot) disseminated various methods of leather processing by means of practical demonstrations. The laboratory also underwent changes in its composition. Several new units, based on high science, were created. Pilot plants for leather chemicals were put up; Chemical engineering, leather products design and manufacturing, footwear design aided by computers and a gait analysis lab. were the latest additions.

Today CLRI presents the picture of a strong technical arm of the Indian leather industry. (See table below for objectives and divisions).

OBJECTIVES AND DIVISIONS

Laboratory	Year of Est.	OBJECTIVES At the time of est.	OBJECTIVES At present (1992)	DIVISIONS At the time of est.	DIVISIONS At present (1992)
CLRI	1953	To ensure benefits of new discoveries in science and technology reached the Indian Leather Industry and helped its development on modern lines.	To carry out R&D work on leather, leather auxiliaries etc. To undertake fundamental and applied research on hides and skins, tanning agents, etc. To transfer technology to the industry	Bacteriology Biochemistry Microbiology Organic Chemistry Inorganic Chemistry Physical Chemistry Director's Lab. Tannery and Control Lab.	Biotechnology Biophysics Organic Chemistry Polymer Chemistry Physical Chemistry Tannery Chemical Processing Pilot Plants Leather Goods/Products Footwear Industrial Safety and risk analysis NMR imaging

A profile of the laboratory is appended.

RRL (Trivandrum)

Just before the commencement of the Fifth Five Year Plan (1975-80) CSIR undertook an active programme of establishing contacts with the State Governments and the industries in the States. Each State was supposed to identify and define clearly the major areas of development to which CSIR could contribute. CSIR also prepared technical notes for consideration by the States.

In March 1971, Shri Achuta Menon, the Chief Minister of Kerala wrote to the Minister of Education, Government of India, requesting that CSIR establish a Regional Research Laboratory (RRL) in Kerala. This was followed by further requests from the State Government, from time to time. Kerala did not have a national laboratory of CSIR, though there was a regional centre of the National Institute of Oceanography (NIO) at Cochin and an extension unit of the Central Food Technological Research Institute (CFTRI) at Trichur.

Dr. Nayudamma, the then Director-General, CSIR, and Shri Menon met in Trivandrum in February 1974, with the latter presiding. They were accompanied by several senior officials on both sides-Directors of five national laboratories of CSIR and Secretaries of the State Government. The following decisions were taken:

i) the fields that could be taken up immediately are:

   a) spices technology (CFTRI)

   b) survey and analysis of materials for glass-ceramic industries, and

   c) an engineering centre by CMERI

ii) NML would assist in setting up pilot and proving plants in association with industry and design and development concerns;

iii) CSIR would set up a polytechnological clinic for providing information and consultancy. This would also act as a nucleus for a technology information and liaison centre for all the CSIR laboratories.

   A metallurgist would be posted as part of the clinic for ready reference of the problems of minerals and metal industries and corresponding liaison with NML.

iv) CSIR would function in the closest cooperation with the Fertilizer Engineering Development Organisation and the Kerala Industrial Technical Consultancy Organisation;

v) the Spices Group of CFTRI, Mysore and a group for survey and testing of minerals and ceramics by CGCRI would be set up by May 1974.

vi) a MERADO Centre would also start functioning in Cochin by May;

vii) the laboratories set up in Kerala would have an autonomous character, and be directly under the CSIR management. However, some of the industrialists, officials of Kerala Government, Universities and technologists and other interested groups could be associated with the technical advisory committee and programmes committee of the laboratory;

viii) the existing building and facilities of the Industrial Research and Testing Laboratories of Kerala Government situated at Trivandrum will be taken over by CSIR to initiate the functioning of a polytechnological clinic and other activities of CSIR;

ix) the existing assets and liabilities of the above laboratory would be adjusted against the State Government's contribution to CSIR;

x) the land adjacent to the existing Kerala Laboratory in Trivandrum could be used for setting up of pilot plants and workshops and future extensions of the laboratory;

xi) Kerala Government would make available about 100 acres of land in Cochin to set up CSIR laboratories for major activities;

xii) Out of the existing staff of the Industrial Research and Testing Laboratory, Kerala, CSIR may select the staff for its requirement and the rest would be found alternate assignments in their parent Department of Industries.

xiii) the Directors of various CSIR laboratories be requested to indicate their proposals for setting up their R&D units and the requirements of floor area, etc.

In a subsequent discussion between DGSIR and the Chief Secretary, Kerala (13.2.1974) it was agreed that the State Government would financially participate in the project.

The Chief Secretary, Kerala gave an indication that the State has proposed a Five Year Plan provision of Rs. 100 lakh for science and technology and could perhaps place this amount with the CSIR as a suitable annual block grant.

This grant would be reviewed every five years and coordinated with the Five Year Plans of the State.

The existing assets and liabilities of the Industrial Testing and Research Laboratory at Trivandrum and the land made available both at Trivandrum and Cochin would be adjusted against the State Government's contribution to CSIR.

These ideas were considered by the Governing Body of CSIR at its meeting on 26.2.1974 and 2.5.1974. In its meeting held on 5 August 1975 GB approved of the proposal for (a) setting up a complex of CSIR activities in Trivandrum and Cochin and (b)taking over the Industrial Testing Research Laboratory in Trivandrum as a nucleus thereof.

The Chief (Administration) of CSIR wrote to the Chief Secretary to the Government of Kerala on 4 September 1975 stating 'that necessary steps are now being taken for the following.

a) The Industrial Testing Research Laboratory (ITRL) at Trivandrum will be taken over by the CSIR along with all assets and lands on which the laboratory is located;

b) the appropriate members of the staff in the ITRL who have been found suitable for appointment in the CSIR will be given adhoc appointments till they are absorbed against regular vacancies, the recruitment for which will be done in accordance with the normal procedures.

c) Units of the CFTRI, Mysore and CGCRI, Calcutta will be set up in the premises of the ITRL, Trivandrum.

d) a Polytechnolgical clinic consisting of nucleus staff would be posted by the CSIR and located in the ITRL premises.

e) in due course of time, the other laboratories, namely, CMERI, Durgapur, CSIO, Chandigarh and NEERI, Nagpur will also establish their Units at Trivandrum/Cochin as the case may be and

f) Steps would also be taken in regard to future development of the CSIR Complex in accordance with our communication of even number dated 22nd May, 1974.

By now, it was fairly well known that Kerala wanted a RRL. DGSIR referred to the commitment made by the Minister for Industrial Development, Science & Technology in the Parliament in regard to the location of a national laboratory in Kerala.

In the 76th meeting of GB held on 6.10.1978, the then Director General (Dr. A Ramachandran) explained the circumstances. The Governing Body approved that the CSIR Trivandrum Complex be renamed the Regional Research Laboratory, Trivandrum. RRL (Trivandrum)'s profile is appended.

RRL(Bhopal)

The National Laboratories of CSIR were spread out in the country, almost each State claiming to have one. The States that did not have them started the process of acquiring them. Madhya Pradesh began building up a case in this regard. Apart from political interests there were other groups-scientific, educational-who also evinced interest in the setting up of a national laboratory in MP. As early as in July 1972, the then Director General of CSIR, Prof. Y. Nayudamma wrote to the Chief Minister of MP expressing a desire to discuss problems of mutual interest to CSIR and the State with representatives of the industry and the Government. This was pre-emptive action of a kind; for, Nayudamma had sensed what was to come. Nothing but a bureaucratic acknowledgement from the State Govt. came out of this. Nayudamma made another attempt in January 1973, by which time the State Government officials were writing to CSIR on the question of establishment of a Regional Research Laboratory (RRL) in Madhya Pradesh. The Chief Minister of the State was not available for DGSIR for the second time. In the meantime officials on both sides were corresponding regularly.

The Chief Secretary wrote to DGSIR on 12 Feb. 1973. DGSIR had this letter attended to by his Advisers in CSIR.

This process went on for more than two years by which time CSIR had indicated what it would like the State Government to do and the State Government had made it known to CSIR that it wanted the laboratory for ever so many reasons.

Finally on 29th August 1975 Nayudamma achieved what he asked for. A meeting between him and the Chief Minister of MP, with Advisers on both sides in attendance took place at Bhopal. This meeting was crucial because several industrial development problems of the State and how R&D -particularly CSIR - could contribute, were discussed. What followed was indeed interesting. The MP State Government representative and the Chief (Technology Utilisation) CSIR prepared record notes of discussions independent of each other. Most of the points were covered by both sides, but there was no particular mention of a RRL of CSIR at MP in the note prepared by CSIR. On the other hand the State Government note said that "it was agreed on principle that a RRL would be set up by the CSIR in the State".

The CSIR note mentioned of various options open and concluded "a CSIR Polytechnological Clinic (PTC) would be established in Bhopal with the financial participation (50%) of the State Government." Nayudamma sent this note to Shri PN Haksar the Vice

President CSIR who agreed with DG's approach. "We have to be hard -headed and realistic" he commented, "I am personally interested in A at p. 4." He was referring to utilization of waste material from Bhilai Steel requiring the attention of the proposed R&D establishment.

In September 1975 the State Government formed a committee with the Director RRL (Hyderabad) as a member to prepare a management and investment report for establishing a RRL of CSIR in Madhya Pradesh. The Committee had other MP Govt. officials also as members. The Report was made available in January 1976 and, as subsequent events showed, formed the firm technical basis for the establishment of a RRL at Bhopal.

As the Report was being examined, CSIR included the proposal in its Fifth Five Year Plan (1975-80).

The Committee identified three major areas of thrust for R&D effort in the state, viz. forests, minerals and agro-products. The report of this Committee was scrutinized by another Committee consisting of the Secretary, Department of Science & Technology, Govt. of India as Chairman and the representatives of the Planning Commission, Ministry of Finance, RRL (Hyderabad), NGRI and CSIR as members. The Committee recommended to CSIR the establishment of a laboratory for the areas identified.

The proposal for the establishment of a research laboratory in the State of Madhya Pradesh (incorporating the recommendation of the second committee) was considered by the Governing Body of CSIR at its 72nd meeting held on 25 November 1976 and the following decisions were taken:

- The laboratory might be established on the pattern of CSIR Complex in Kerala; it may start with a new style of management and not based on the conventional set up of national laboratories.
- Emphasis should be more on building up of design, engineering and development capabilities and appropriate technologies keeping in view the requirements of the State of Madhya Pradesh. The laboratory should be project-oriented in its approach.
- The funding pattern should be in accordance with the provision made in the Fifth Plan.
- The proposal of the Govt. of Madhya Pradesh to share 40 per cent of expenditure in the scheme was agreed to as a special case, the CSIR might share the remainder sixty per cent of the expenditure.

- **The laboratory should not be called the Regional Research laboratory but its name might be decided by DGSIR in consultation with the President CSIR.**

Thereafter, negotiations between CSIR and the Govt of Madhya Pradesh started with regard to the location, site etc. of the proposed laboratory.

From time to time the Planning Commission had indicated resource constraints. But the Madhya Pradesh Govt. were pressing and brought the matter to the attention of the Prime Minister (the President of CSIR).

When the above facts were brought to the attention of the then DGSIR (Dr. A Ramachandran, since Nayudamma had left), he preferred to await the clearance of the Planning Commission (This was in August 1978). He did so because at the meeting held in the Planning Commission (on 27-12-1977) the Annual Plan 1978-79 of CSIR was discussed and the following decision was recorded:

"the proposal for setting up a new laboratory in MP was not supported."

In March 1979 DGSIR (Prof. MGK Menon now, for Dr. A. Ramachandran had left) set up an expert committee with Prof. BM Udgaonkar of the Planning Commission, as Chairman to go through the Report and the suggestions of the Member, Planning Commission (Shri V.G. Rajadhyaksha) and make recommendations on the manner in which the laboratory should be set up.

The Committee met in September 1979 and discussed various aspects.

The final report emerged in April 1980.

A profile of the laboratory is appended.

CCMB

In the seventies, molecular and cellular biology represented a frontier area in science. Discoveries in this area had substantial applications in agriculture, veterinary and medical sciences and in industry. Advances in this area provided answers to important basic questions concerning life processes and influenced human thought.

The Bio-chemistry Group at the Regional Research Laboratory, Hyderabad was active in this area of basic and applied research since 1958. It carried out notable work in reproductive biochemistry, preparation and properties of cell suspensions, regulation of growth cell division and malignant transformation and regulation macro-molecular syntheses. In view of the contributions made by this Group, additional inputs had to be provided for its growth and development so that results having wide applicability could be forthcoming.

Realizing the importance of the above, RRL, Hyderabad desired to expand the scope of work in this field by establishing a Centre for Cellular and Molecular Biology. DGSIR (Nayudamma) referred the proposal for examination and recommendations to a committee consisting of the following members:-

Dr. G.P. Talwar,	All India Institute of Medical Sciences (AIIMS), New Delhi
Dr. Obaid Siddiqui,	Tata Institute of Fundamental Research (TIFR), Bombay
Dr. S. Ramachandran,	Hindustan Antibiotics, Ltd., Poona
Dr. T.V. Subbiah,	Alembic Chemical Works, Baroda
Dr. P.M. Bhargava,	RRL, Hyderabad

The summary of the report was as follows:

The Biochemistry Group at RRL, Hyderabad should be developed into a Centre for Molecular and Cellular Biology in RRL, Hyderabad.

The Centre should function as a part of RRL, Hyderabad sharing its common facilities, but should have autonomy and separate budgetary support necessary for its effective functioning.

The objectives of the proposed Centre should be:-

a) to conduct research in frontier and multi-disciplinary areas of modern biology and to seek potential applications of this work;

b) to carry out exploration work in areas of biology with a view to aid the development of biochemical and biological technology in the country on a sound basis. The suggested areas of thrust are:-

studies related to development of newer methods of control fertility. studies related to development of biology-based pest control methods; studies on genetic engineering in plants and micro-organisms which may, for example, lead to reduction in the requirement of chemical fertiliser.

c) to train people in the advanced areas of biology with special provision for short term training of staff from other institutions in techniques for which adequate facilities may not exist elsewhere;

d) to provide centralised facilities in the country for new and modern techniques in the inter-disciplinary areas of biology and to ensure that these facilities are put to maximum use by research workers from other laboratories and institutions in the country;

e) to interact adequately with other institutions doing basic or applied work in areas related to the activities of the Centre; and

f) to collect, collate and disseminate information relevant to biological research.

The report also contained suggestions regarding the pattern of organisation of the centre and details of facilities available in the Biochemistry Group and other Divisions at RRL, Hyderabad.

The above report was referred by DGSIR to another committee comprising the following persons to scrutinise and give their recommendations:-

Dr. A. Ramachandran Secy. Deptt. of Science & Technology	Chairman
Shri A.B. Datta, FA to CSIR	Member
Shri M.R. Raman, Jt. Director (Science), Planning Commission	Member
Dr. G.S. Sidhu, Director, RRL Hyderabad	Member
Shri A. Rahman, Chief (Plg.) CSIR	Convener

The following are the recommendations of this committee:-

"The committee considered the report of the committee constituted by DGSIR and its recommendations for setting up of a Centre for Cellular and Molecular Biology at Regional Research Laboratory, Hyderabad and decided that:

- Cellular and Molecular Biology was an important and emerging area of research and major project support should be provided to this area;
- Major support for recurring and non-recurring expenditure should be provided to this area of activity upto Rs. 1 crore till the end of the present plan period;
- In order to attract people and to enable the group to develop to a critical size, the project should have a five year perspective both with regard to the area of development as well as investment; and
- The project should have flexibility of operations and a separate scientific advisory committee.

The establishment of a Centre for Cellular and Molecular Biology was included in the CSIR Annual Plan for 1976-77.

The Governing Body was requested to approve the setting up of a Centre for Cellular and Molecular Biology at RRL, Hyderabad in terms of the recommendations of the committee constituted by DGSIR for the purpose and the committee headed by Dr.A Ramachandran. The Governing Body approved the proposal (on 29.6.1976) subject to further scrutiny by DGSIR of equipment, personnel, finance/building requirements. The Centre would function as a semi-autonomous Institute.

The Objectives and Divisions of RRL (Tvm), RRL(Bhopal) and CCMB are shown in table below.

(The Laboratory profiles are in Appendix V)

OBJECTIVES AND DIVISIONS OF THE LABORATORIES

Laboratory	Year of Est.	OBJECTIVES At the time of est.	OBJECTIVES At present (1992)	DIVISIONS At the time of est.	DIVISIONS At present (1992)
RRL (Triv)	(1976)	(Technological back-up to the industries in the region through R&D and technology transfer). Develop technologies for the optimal utilization of the resources of the region and help industries of the region through research, development and technology transfer.	same	(Rohatgi) Food Division Materials Division Ceramics & Glass Division Systems Planning & Research Management Division.	Plantation and bio-organic materials Clay, Ilmenite and other minerals Value added products from primary materials; Pollution;.
RRL Bhopal	(1981)	Development of engineering metals, alloys and composites; building materials, aluminium technology and pollution control.	same	(Rohatgi) Mineral based materials; Forest and agro-based materials; Systems Planning; Research Management. 1986 (Rajendra Kumar) Building materials Aluminium, metallography Electrochemistry, agro-forest, fibre, polymer composites, minerals and ceramics; non-conventional energy sources	(T.C. Rao) Bldg. Materials Metallurgy and materials Minerals Resources Development
CCMB	(1981)	To conduct research in frontier and multidisciplinary areas of modern biology and to seek potential applications of this work; to carry out exploratory work in areas of biology etc.	same	CCMB has no conventional divisions or departments. It carries out basic research in frontier areas of modern biology by having different research groups centred around individuals of proven competence and leadership.	

TTRS

It was some time in March 1974 that the Director of the Central Power Research Institute, (CPRI), Bangalore, wrote to the then DGSIR asking for details of a project on the Tower Testing Research Station (TTRS) proposed by CSIR. His source of information was a newspaper report on the topic. He gave DGSIR to understand that CPRI was also constructing a Tower Testing Station in Bangalore to be commissioned soon. DGSIR (Dr. Nayudamma) wrote to Prof. G.S. Ramaswamy, Director of the Structural Engineering Regional Research Centre at Madras, to find out if it was still necessary for CSIR (and SERC) to put another Tower Testing Station near Madras. The Director was also requested to write to CPRI giving the details of the proposal.

The Structural Engineering Research Centre (SERC) had been engaged for quite some time in the development of optimum designs for transmission line and micro-wave towers through sophisticated computer programmes developed for the purpose. These programmes, which would help to prune the weights of towers by nearly 10%, were made use of by several tower manufacturers for the design of towers for domestic as well as export markets. Further improvements in designs could be effected if the results of analysis were backed by test results. Testing of towers was a contractual obligation.

SERC had, therefore, proposed, as early as in 1970, the establishment of a tower testing station primarily as an R&D facility but undertaking commercial testing as a service to industry and for using the test results as feedback for improving tower designs.

This facility proposed at the same time by an Institute of the Govt. of India and a national laboratory of CSIR occupied the attention of the decision makers on both sides for the next three years. During this period, SERC at Madras which started as a regional centre of the main laboratory at Roorkee, became the headquarters.

The Centre (SERC) was established as a National Laboratory under CSIR in June, 1965, to develop as a research school for specialised design and development work in all types of structural problems. The Centre was located on the campus of the Central Building Research Institute (CBRI) Roorkee. The erstwhile Division of Structural Engineering of CBRI formed the nucleus of the Centre. Its location on the CBRI campus with less than two acres of land at its disposal and surrounded by the buildings of CBRI imposed severe limitations on its expansion. The Director of CBRI had also requested that the existing space be left to meet the expansion needs of CBRI.

The Madras Centre of SERC was established in 1966 on the initiative of the Industry. The State Government allotted an area of about 62 acres of land for the CSIR Complex for use by the various Regional/Extension Centres of the national laboratories at about the same time. These Centres including the Madras Centre of SERC were established there.

The then Director of SERC (Prof. G.S. Ramaswamy) was stationed at the SERC Headquarters at Roorkee since its very inception; but in 1971 his Headquarters were changed to Madras. This was perhaps done due to the increasing demand on the services of SERC there, and to enable the Director to give his undivided attention to meet the same. Originally, the change of Headquarters of Director was for a period 2 years which was subsequently extended. In spite of the change of the Headquarters of the Director from Roorkee to Madras, the Headquarters of SERC remained at Roorkee.

A proposal to shift the Headquarters of SERC to Madras was placed before the Governing Body in October, 1974 at the suggestion of the then Director. The proposal was, however, withdrawn. It was again taken up on 3rd October, 1978 by the then DGSIR (Dr. A.Ramachandran) and after obtaining the approval of the Vice- President, CSIR, orders were issued to transfer the Headquarters of SERC from Roorkee to Madras.

With regard to TTRS, CSIR attempted to bring SERC and CPRI together to iron out the differences and difficulties in the implementation of the project at Madras. The Director, SERC Madras spared no efforts to establish his claim that the proposed tower testing facility at Madras was quite different from the one proposed at Bangalore. According to him it was more sophisticated and modern in design. He also provided enough evidence of support of the industries connected with the production and testing of transmission line towers in general.

In the meanwhile the arguments between SERC and CPRI as to the institution where the facility should belong, continued. In fact the Joint Secretary in the Ministry of Energy, Department of Power, Govt of India, at one time, wrote to Prof. Ramaswamy stating that "the Central Electricity Authority had felt that the transmission tower testing station proposed at Madras by SERC may not be pursued at this stage". This was some time around February 1977. But by December 31, 1976, Prof. Ramaswamy had sought voluntary retirement from CSIR to enable him take up a UN assignment abroad.

The issue cropped up again with an added dimension in the form of UNDP assistance to the project. The project was supposed to be considered as any other institutional project and examined by a technical committee appointed by DGSIR.

DGSIR set up a committee under the Chairmanship of Shri Tata Rao of the Andhra Pradesh State Electricity Board, and representatives of industries, the Ministry of Energy and the Central Electricity Authority as Members. The Committee was to examine the project report submitted by SERC Madras, as well as the earlier reports, for the establishment of a Tower Testing Station vis-a-vis existing capabilities and, if found viable, recommend the project for being taken up by CSIR with UNDP assistance. The Committee was also expected to determine the location of this facility.

The Committee met at SERC Madras on 12.8.77 and after considerable discussion approved the project for implementation by CSIR. The establishment of the Tower Testing Research Station (TTRS), as a major project of SERC Madras, to be known as a national facility was approved by the Governing Body of CSIR in September 1977.

Then started the activities with regard to acquisition from the State Government a suitable piece of land and construction of test pad, instrumentation facilities and essential structures to house the computer. The Station became operational in 1984- ahead of schedule.

A sequence of events leading up to the establishment of these six laboratories and TTRS is presented below:

Sequence of events of establishment:

NCL and NPL

1941	Bhatnagar proposes establishment
1942	CSIR is born, tentative plans for NPL, NCL etc.
1943	Governing Body sets up two committees for NPL,NCL
1944	Locations decided
1945	Land for NPL acquired, Plan for NPL approved
1947	Foundation stones for NPL and NCL laid Directors of NCL/NPL appointed (Dr. Siddiqui-NCL and Dr. KS Krishnan-NPL)
1949	Director NCL takes over (Prof. J.W. McBain)
1950	NPL and NCL formally inaugurated.

CLRI

1946	BSIR approves establishment of CLRI (as recommended by LRC)
1948	Madras as location approved.CLRI starts functioning in a "domestic atmosphere" in Coral Merchant St., Geroge Town, Madras. Later shifts to AC College of Technology (adjacent to where CLRI now is).
1948	Foundation stone laid
1948-51	Planning Officers appointed.
15.1.1953	Director appointed. Formally inaugurated

RRL Trivandrum

March 1971	Kerala Chief Minister writes to Union Minister of Education. Followed by requests of Kerala Govt. officials for a Lab.
February 1974	Kerala Chief Minister and DGSIR meet. (Decisions to set up CSIR units in Kerala taken)
May 1974	Governing Body of CSIR approves CSIR Complex at Trivandrum.
1976	The Complex is established
1977	Director (Rohatgi) is appointed.
1978	Minister of Industrial Development, Science & Technology reported to have made a commitment in Parliament for a RRL in Kerala.
October 1978	GB, CSIR approves CSIR Trivandrum Complex be renamed RRL Trivandrum.
1979	RRL Trivandrum, established.

RRL Bhopal

July 1972	DGSIR writes to the Chief Minister of Madhya Pradesh.
January 1973	DGSIR makes another attempt to contact CM.
February 1973	The Chief Secretary of Govt. of MP writes to DGSIR.
August 1975	Meeting between CM and DGSIR - officials on both sides present.
Sept. 1975	A technical committee set up by MP Govt.
Dec. 1975	GB, CSIR, approves of setting up of a PTC at Bhopal.
January 1976	Report of the technical Committee out

Nov. 1976	GB considers the Report with other recommendations; approves CSIR interest in MP. (The lab. should not be called RRL)
Dec. 1977	Planning Commission does not agree
August 1978	PM (Morarji Desai) writes to the Chief Minister of MP saying he had asked DGSIR to expedite.
March 1979	DGSIR sets up another Committee.
April 1980	Report is submitted
1981	A Director (Rohatgi, Director RRL Trivandrum) is appointed. Laboratory starts functioning.

CCMB

1975-76	Talwar Committee suggests formation of CCMB Recommendations supported by an interdepartmental Committee.
1976	GB approves
1977	CCMB comes to be established as an autonomous centre (Dr. PM Bhargava takes over as Director) CCMB becomes a separate Laboratory.
1988	In its new premises, CCMB is dedicated by PM (Rajiv Gandhi) to the cause of Science to the Nation.

TTRS

March 1974	Director, CPRI, Bangalore writes to DGSIR re: a Tower Testing Station proposed by CSIR.
February 1977	Central Electricity Authority tries to dissuade SERC(M)
August 1977	An expert Committee appointed by DGSIR examines project reports and recommends the setting up of TTRS.
Sep. 1977	GB, CSIR approves setting up of TTRS by SERC(M) at Madras.
1978	Project initiated
1981	UNDP assistance
1982	Land acquired
1984	Arrival of Equipment
	Commissioning of the Station
	First tower tested (for R&D purposes)
1985	First tower tested (Commercial)

What were the factors responsible for the establishment of these national laboratories? Were they internal or external or both? These questions are answered by identifying the factors from the way they came up and analyzing them one by one, in the following chapter.

CHAPTER-VI

ANALYSIS OF DATA

An analysis of factors that were responsible for the establishment of these laboratories is undertaken in this chapter. A good part of this analysis has to be historical, particularly because some of the laboratories came up at a time when historical changes in the political set-up of the country were taking place. The first two laboratories - NCL and NPL - have to be taken together.

NCL and NPL

It has been pointed out that the first four National Physical Laboratories of the world were started at Paris (1875), Berlin (1887) London (1899) and Washington (1901).

The needs of a Government agency to stimulate industrial expansion and increase industrial efficiency brought about the establishment of National Laboratories for Physics and Chemistry elsewhere. The question of setting up such laboratories in India had been under discussion for several years. Since 1935, Science and Culture had, while reviewing the activities of NPL of the UK, argued in favour of starting similar laboratories in our country.

In September 1941 Dr. S.S. Bhatnagar, Director BSIR, wrote to the member in charge of commerce stressing the need of establishing a Central Laboratory which could be divided into Physical and Chemical Laboratories.

To go back a little further in Time. The post-war period saw some rumblings in the scientific scene in India. The Indian Industrial Commission (IIC) was set up in 1916 under the Chairmanship of Sir Thomas Holland. The next important step taken by the then government was the constitution in 1934 of the Industrial Intelligence and Research Bureau (IIRB).

By this time political activity in the country had become quite marked. The leadership lay in the hands of Nehru who understood the importance of Science in the industrial development of the country. Baldev Singh in his introductory remarks to the book "Jawaharlal Nehru on Science & Society" says "The studies during the years 1930-33, the years after return from Europe and the Soviet Union really mark the emergence of the Scientist in Jawaharlal Nehru: by 1933, he had accepted Science and scientific method as the enlightened approach to social, political and economic problems and considered socialism as the logical approach to economic development consistent with scientific methodology."

Thus the dominant personality of a progressive leader was an important Internal contributory factor in the establishment of the first chain of national laboratories. Further events only confirm this. In 1938 was formed the National Planning Committee with Nehru as the Chairman. Two scientists Prof. Meghnad Saha and Prof. PC Mahalanobis figured prominently in the Committee.

The Board of Scientific and Industrial Research (BSIR) was established in April 1940. This was because of the major strength the Indian scientists had in the person of Sir A Ramaswamy Mudaliar, the Commerce Member in the Government of India. But for his vision BSIR would not have been founded then. Dr. S.S. Bhatnagar was named the Director of BSIR. By August 1940 Dr. Bhatnagar had taken charge of the Government Test House, Alipur, Calcutta, which continued to be the nerve centre of the newly created BSIR.

An advice on the kind of set-up needed to administer the affairs of BSIR and the need for the early establishment of the Physical and Chemical Laboratories was forthcoming in the May 1940 issue of Science & Culture: "The existing Government laboratories as well as those of the universities are not at all sufficient to cope with the amount of work which will have to be carried out if the problems are to be tackled in right earnest. It is necessary that several new research institutes be established with specific purposes e.g. a National Physical Laboratory to standardize all instruments and meters used in commerce and industry, as well as to organize researches which require far costlier equipment than a normal university laboratory is expected to process. In addition to the above, there are needs for a National Chemical Laboratory possessing both analytical and developmental sides".

It is evident that by 1940 enough pressure had been built by eminent Indian Scientists to set up National Laboratories for Physics and Chemistry to begin with. Dr. Bhatnagar too wrote to the Commerce Member.

A step in the direction of linking research with industry was taken when in early 1941 the Government set up an Industrial Research Utilization Committee (IRUC) whose main function was to advise the Government on the selection of industries which could utilize the results of research emanating from the implementation of the BSIR schemes. But a more positive step was taken in September 1942 when thanks to Sir A Ramaswamy Mudaliar the Council of Scientific and Industrial Research was established as a Society, with grants from the

Government. The formation of CSIR laid the foundation of a new era of scientific and industrial research.

The war years saw some slowing down of activities as far as establishment of laboratories was concerned and work at the Alipore Test House continued. Early in 1942 the threat of Japanese invasion made Calcutta unsafe for the location of the centre of scientific activities as were planned by BSIR and so accommodation for the central laboratories of BSIR was made available by the Delhi University. The nucleus furnished by the Industrial Research Bureau to the BSIR laboratories continued under Dr. Bhatnagar's care and its activities continued to flourish and expand to several other fields of work concerning war efforts. It was then that Prof. Hill visited India and made a number of recommendations on pursuit of scientific and industrial research in the country.

By the time Hill came and went back, CSIR had been in existence for nearly two years. There was a proposal in the first meeting of the Governing Body of CSIR in March 1942 relating to NCL.

Tentative plans were offered for the establishment of NPL, NCL, NML etc. in the latter part of 1942. It is interesting to note that in 1943, there was a suggestion that consideration of establishment of NPL and NML be deferred till the end of the War.

The establishment itself was approved in principle and the members (of GB, CSIR) resolved that the Member in charge of Industries and Civil Supplies be requested to take up the matter with the Finance Department with a view to exploring the possibility of inaugurating these laboratories as early as possible.

Planning for NCL and NPL started in 1943-44 and decisions with regard to their locations were also taken. As far as NCL was concerned, Poona (Pune) had already been selected as the place where the laboratory would be located. Location of NPL figured prominently in the discussion at the meeting of the CSIR Governing Body in March 1944. Dr. M.N. Saha argued that such a big institution should not be under one Director and that it should be broken up. Some of its branches could better be located in places other than Delhi.

Sir Aziz-ul-Haque, presiding over the meeting, stated that in view of the work done in Bengal on this subject he felt that NPL should be located at Calcutta but if the majority were in favour of Delhi he would abide by their decision.

The Governing Body had before it all the details of the meeting of the NPL committee held in August 1944 at Hyderabad. This included a long letter from Dr. D.M. Bose, Bose Institute, Calcutta to Dr. K.N. Mathur, Assistant Director (Planning), CSIR, giving his reasons for locating the laboratory at Calcutta. Dr. Bose and Dr. Saha could not attend the Hyderabad meeting. There were letters received from the following bodies that NPL should be located at Bombay:

The Maharashtra Chamber of Commerce, Bombay;

The Indian Merchants' Chamber, Bombay;

The Karachi Indian Merchants' Association, Karachi;

The Federation of Baroda State Mills and Industries, Baroda;

The Bombay Shroffs' Association Ltd., Bombay.

It was finally decided by the Governing Body that NPL would be located at Delhi.

It was alright for CSIR GB to decide but the group of scientists connected with Science & Culture decided to take the matter further. In its June 1946 issue the journal proceeded to deal principally with the recommendations of the Physics and Chemistry Planning Committees (got ready for CSIR GB in mid 1945).

The recommendations of the Planning Committee were supposed to be based on the model of the British Laboratory at Teddington, whose functions were to make accurate determinations of physical constants, to establish and maintain precise standards of measurement, to make tests of instruments and materials, and in addition to undertake investigations on special problems submitted to them on behalf of government departments, research associations, industrial firms and others.

Later the laboratory was to contain departments for physics, electricity, radio, metrology, engineering, metallurgy, aerodynamics and a William Froude laboratory for researches on problems of ship building.

Here the report in the journal broke away and took off in a different direction. It pointed out that Calcutta was a better location for NPL, as compared to Delhi. The reasons why there should be a separate Central Radio Research Laboratory were also cogently laid out. "We are glad......" it concluded " to note that the question of establishing one will be taken up as and when funds permit". "In the meantime in order that the investigations in other branches of physics may not suffer for want of an electronics and sound section --since electronics now enters almost every branch of physical measurement – a small division on electronics and sound should be included in NPL. It will not matter much if there is some overlap in the scope of investigations undertaken in the proposed Radio Research Laboratory, and the Electronics and Sound Division of NPL."

The Planning Committee of NCL decided that the Laboratory would concern itself in developing the means for the application of scientific knowledge to practical problems of human welfare, and its work will be largely of fundamental, basic and applied nature on lines likely to promote research on industrial chemistry and the chemical utilization of raw material resources so as to help the development of the country and its industries. According to the report, "the problems of industry are never such as fall within the narrow groove represented by a particular branch of chemistry. More often than not, for the successful solution of a problem, the cooperation of experts from different fields of science is necessary. NCL, therefore, will embrace not only chemistry but also physics, mineralogy, engineering and biology, in so far as they relate to chemical problems and the chemical utilization of national resources." Citing the examples of the Mellon Institute and of MIT which had highly developed departments of Biology and of Biological Engineering, the review proposed that "NCL will have sections of Chemical Engineering and of Biochemistry, including Biological Evaluation."

The review continued : "It appears to us that much of the subject matter included under Biological Evaluation can with advantage be left to the Central Biological Products Laboratory and to the Central Drugs Laboratory".

"We suggest that instead in this division cooperative investigations be taken up with biologists, on the most efficient method of Biological Utilisation of Solar Energy. According to E.W.D. Sinnot (Am. Nat. 79, 28,1945) the substance and energy of modern life will come largely from currently produced plant materials. Although chemistry can produce vast number of products from a single raw material, the original organic molecule must be produced by plants. Consequently the plant biologist needs must investigate the areas, environments and plant types for the most efficient basic synthesis of carbon compounds and amino acids. Much progress can be made by a study of the tropics and the ocean, where the processes are carried out at a very high rate. Better utilization should be made of forest products, since photo-synthesis and the determination of optimum conditions offer more problems than can be handled by the present number of biologists. Possibly work of this nature can be undertaken in collaboration with the Forest Research Institute, Dehradun. Some work of the nature of background research can also be usefully undertaken by NCL."

The methods employed for investigations of subjects included in Division II Physical Chemistry including Electrochemistry, and in division III Chemistry of High Polymers are principally physical in character and hence an additional section of Chemical Physics might have been profitably included".

The commentary ended with a cryptic remark -"It would have been of mutual advantage if both the laboratories were located near one another, as has been done both in England and in the USA". Indeed the sweep of subjects dealt with here was wide; and today we have many laboratories covering them in different aspects.

The foundation-stone of NPL was laid by Nehru on 4 January 1947 in the presence of a distinguished gathering including Sir Charles Darwin of NPL, UK. The NCL foundation stone was laid on 6 April 1947. Prof. J.W. Mc Bain took charge as Director in September 1949. A group of biochemists and a group on oils and fats began to work in the basement of the laboratory building a few months before the official opening ceremony. A few other organic chemists who were already working in the CSIR laboratories in Delhi shifted to Pune early in 1950. NCL was inaugurated by Nehru on 3 January 1950.

The hopes and aspirations of the founders of NCL were best expressed by Nehru in his address during the foundation stone laying ceremony.

"The establishment of NCL is an event of considerable importance for the development of scientific research in India. Original work in chemistry is the foundation of national industrial progress and I hope that the new institution will make its full contribution to the development of our material resources."

On January 21, 1950 NPL was formally inaugurated by Sardar Patel the then Deputy Prime Minister in a function presided over by Shri C. Rajagopalachari, the Governor General of India. The galaxy of Indian and foreign scientists and political leaders present at the time included Sir Robert Robinson, President of the Royal Society, Prof. P. Alugers, Director of Science, Unesco, Paris, Prof. W.D. Engelhardt, Prof. JD Bernal, Dr. K.S. Krishnan and Dr. SS Bhatnagar.

Nehru ended his speech saying, "when I think of the tremendous adventure in Science in the past and the tremendous adventure that I hope it is going to be in the future, I am fascinated by this prospect and I feel how much better it would have been for me to be the Director of this Institute if I had the competence than to be the Prime Minister".

Thus in January 1950, almost after ten years of conception, were born the National Physical and Chemical laboratories, the first two in a chain of eleven, referred to by the authors of the CSIR Saga as "the Bhatnagar Eleven".

Internal and external factors, combined with the push that dominant personalities- Nehru, Bhatnagar, Saha- gave to the idea, saw the emergence of these two laboratories. An important additional factor was the Times when these were brought about. India was just going to be independent. There was an intellectual ferment which foresaw the use of Science and Technology for social transformation. A good measure of this arose as a result of the education the Indian intellectuals, particularly the scientists had received in India and in the West. For Saha, Mahalanobis and the group they led, the Soviet model of planning appeared quite attractive. How much of correlation that the work of these laboratories (of CSIR) had with the industrial development of the country and what kind of Industrial Research these laboratories undertook for achieving that correlation, are matters which need be studied separately.

As a matter of fact such inquiries or mid-term appraisals were made from time to time. They were in the nature of reviews made by committees of eminent scientists, industrialists and civil servants.

The constitution of these reviewing committees is a requirement to be found in the Rules and Regulations governing CSIR.

In August 1947, the Governing Body of CSIR set up the First Reviewing Committee with Sir Ardeshir Dalal as the Chairman. There was no laboratory of CSIR in existence then; yet some idea of the way NPL was being planned was revealed.

"Sir K.S. Krishnan has brought to the notice of the Committee that as the National Physical Laboratory was planned on the model of NPL, Teddington, no provision for a section on industrial physics has been made. He is of the opinion that such a section is absolutely necessary for NPL and the Committee strongly endorses his view".

The Second Reviewing Committee of CSIR, under the Chairmanship of Sir Alfred Egerton, Emeritus Professor, Imperial College of Science and Technology, London submitted its Report in April 1954. The Report quoted Lord Moulton FRS (commenting many years ago on the work of NPL, Teddington, England) that a NPL should "set the standards of accuracy for the Nation", and recommended continuation of fundamental work, extension of work relating to standards to measurements on thermal properties of gas, liquid and solid systems, and much attention to be given to the requirements of industries and the necessary applied research work.

On NCL the Committee had this to say - the main object of the laboratory viz advancement of chemical science and application of chemistry for the welfare of the people, was being kept in view. It was clarified that the progress of chemical industry depended on the pool of knowledge gained from fundamental work and if the pool dried up industry had nothing to draw upon. The Committee felt that 30 per cent of the total effort of NCL could be directed towards fundamental work.

Two specific recommendations were:-

Close touch be maintained with other research laboratories and institutes and with industries; for the present NCL should be the Chief Centre for research for the paint, paper, printing and other chemical industries.

It was not until 1964 that the Report of the third Reviewing Committee headed by Sir A.Ramaswamy Mudaliar, appeared.

But just a year before in 1963, Prof. PMS Blackett visited NPL, and made a few observations on its restructuring. He considered the major role of NPL over the next decade was in the field of standards and testing of commercially manufactured instruments, equipment and apparatus. He also strongly recommended that the Radio Components section and the Ceramic pilot plant be taken out of NPL and continued to make a commercially run government owned manufacturing plant, preferably on its own or alternatively as a subsidiary of a bigger firm such as the Bharat Electronics Ltd. He found the Radio Propagation Unit under AP Mitra 'first class' and recommended full support. Industrial Physics, Transistors, Time and Frequency and Analytical Chemistry divisions were also found to be competent.

Blackett recommended taking away of the basic research work and placing it in Delhi University. The laboratory might be called the 'Centre for Advanced Physics of Delhi University and CSIR.'

The Mudaliar Committee agreed with the policy advocated by Blackett and accepted by the Executive Council of the laboratory in that greater emphasis should be given to the applied work of the laboratory. The applied work should develop around standards and testing.

The Committee also suggested that NPL could provide valuable support to the scientific instruments industry, in collaboration with the newly established Central Scientific Instruments Organisation (CSIO), at Chandigarh.

Two general principles set out were:-

Research Laboratories should not be formally divided into separate wings 'Pure'and 'Applied'. This tends to isolation and intellectual snobbery. Matters are made worse if the two wings become administratively separate with separate directors.

If Centres of Advanced Studies are to be set up in any scientific discipline such as Physics, these should be set up in universities and not as parts of CSIR establishments. CSIR can be of the greatest assistance to the formation of these units both financially and in other ways, but the universities are the natural and appropriate homes for 'Advanced Studies'.

A solution to the residual problems of NPL had to be sought by the application of these principles.

It was sought: NPL would continue to be a single entity.

The Committee made specific recommendations regarding the focus of work of NCL. It agreed with the criticism that NCL was too 'academic' and had been of insufficient help to the chemical industries. A 80:20 ratio between applied and basic work was recommended. The following subjects were suggested to be tackled:

Intermediates

High Polymers

Fermentation Chemicals

Inorganic Chemicals, specially those containing

rare Elements from indigenous sources

Dyestuffs and textile auxiliaries

Catalysts and catalytic reactions

(Pilot plants, chemical engineering etc.)

The Committee also recommended progressive reduction of the number of research fellows doing PhD work at NCL.

The next Reviewing Committee came to be set up more than two decades later. The Committee, headed by Shri Abid Husain submitted its Report (entitled Towards a New

Perspective) in December 1986. It did not make any particular recommendation regarding the National Physical and Chemical Laboratories.

In a recent internal review by the Director NCL, it was realized that the first fifteen years were devoted to building up a high order of capability in chemistry and chemical engineering. In the late sixties and early seventies NCL did considerable amount of applied research work by developing processes for industrial chemicals leading to import substitution. Side by side, the laboratory was establishing its engineering capabilities on a firm footing. In the early eighties NCL shifted its emphasis to high tech areas. In the nineties the laboratory is looking forward to engaging itself in emerging technologies, taking them up to commercialization. The focus will be on - safer chemistry for better environment, new feedstocks to eliminate dependence on petroleum crude, exploration of the biology/chemistry interface and development of advanced and new materials. In order that these R&D programmes are undertaken vigorously, Dr. R.A. Mashelkar, the Director, would like to adopt a more professional approach of inculcating all the positive and strong points of an **industrial culture,** through a variety of managerial reforms and new incentive schemes.

Perhaps the best arguments in favour of establishing a NCL and a NPL in India came with the recommendations in January 1945 of the Industrial Research Planning Committee headed by Sir R.K. Shanmukham Chetty. The Committee recognized that the tentative scheme for NCL" appeared to have a very large scope as seeking to provide accommodation and facilities for inorganic chemistry (including analytical investigations), organic chemistry (including drugs and chemotherapy), physical chemistry (including high pressure technique and electro-chemistry), biochemistry (including biological products) and chemical engineering. NCL was intended to be set up a polyglot institution not so much for any technical advantage for dealing with all the industries in a single institution as with the object of gaining maximum results from the application of an amount of about Rs.25 lakh which was considered reasonable for such a laboratory".

The Chetty Committee recommended the establishment of a National Chemical Laboratory and a National Physical Laboratory at an estimated cost of Rs. 40 lakh each.

Nine new specialized Institutes were recommended in the order of priority as follows:-

Institute of Food Technology

Metallurgical Institute

Fuel Research Institute

Glass and Silicate Research Institute

Oils and Paints Institute

Buildings and Roads Institute

Leather and Tanning Institute

Industrial Fermentation Institute

Electrochemical Institute

In addition to what was stated in the Report of the committee, there were other factors that helped the formation of the Central Leather Research Institute (CLRI).

CLRI

The Shanmukham Chetty Committee identified in 1945 two institutions established under the auspices of the Government, engaged in leather research. They were - the Bengal Tanning Institute (BTI) at Calcutta and the Leather Trades Institute (LTI),Madras. BTI was being maintained by the Government of Bengal to help the development of the local tanning industry by conducting researches in different problems pertaining to it and also by training students to cater for its needs in respect of technical personnel. The experimental tanneries attached to the Institute were of special value in discharging these functions. BTI was located in an area where a number of tanneries were functioning.

LTI Madras was also provided with experimental tanneries where students were given training in semi-large scale operations. Research work at LTI related to utilization of tannery by products, investigation of suitable indigenous tanning agents as substitutes for imported wattle bark, manufacture of different varieties of leather, problems relating to insecticides etc.

Towards the end of 1945, Prof.BM Das the then Superintendent of BTI, delivered a lecture on Leather Industry and Research in India at the Applied Chemistry Department of the University College of Science, Calcutta. This lecture contained the valid reasons for and the importance of R&D for the Indian Leather Industry. It was almost the first broad plan for the establishment of a Leather Research Institute in India.

Prof. Das proceeded to analyze the functions of the leather industry thus:-

production of raw hides and skins

curing of hides and skins

production of vegetable tanstuff

production of mineral tanning agents and other treatment materials.

tanning or actual manufacture of leather

manufacture of boots and shoes and leather goods

sale of leather boots and shoes and other leather goods in India and abroad.

NONE of the above functions was being carried out as efficiently as was desirable and possible. In each of the functions he could identify the role of R&D to improve the situation. A sum-up of the state of affairs just before the War appeared as follows:

Raw cow and buffalo hides	
Exported Raw	18.4%
Semi-tanned and exported	34.0%
Crudely tanned	35.6%
Well tanned	12.0

	100.00%

Raw goat and sheep skins	
Exported raw	51.0%
Half tanned for export	37.8%
Crudely tanned	6.7%
Well tanned	4.5%

	100.00%

According to Prof. BM Das "Our aim should be to convert all these hides and skins into completely finished leather for local consumption and for the export of the surplus. Big organization and great tanning efficiency are needed to realize this object".

He further reasoned why a CLRI consisting of the required laboratories and a tannery was an urgent need in India. The following note is a **direct industry-research link-up idea which can be cited as an inherent and positive factor for the establishment of CLRI.**

"Chemical,physical, physico-chemical and bacteriological reactions are involved in modern leather manufacture. These reactions have a profound influence on leather quality.

Unless these reactions are properly carried out and controlled, leather of good and uniform quality cannot be turned out. Years of practice and intensive scientific research in leather technology have enabled the leather industries of Europe and America to make phenomenal advances and to raise the standards of quality of their products to a very high level. Indian leather industry has to compete with those products both in the Indian and foreign markets to which later the surplus products of India have to be exported. This export will increase as the production of leather and leather goods in India expands. Unless the quality of the Indian goods is raised to the level of the Western products competition will be difficult and the development of the Indian Leather industry will be hampered. The only way to raise the standard and to keep it up at a high competitive level is by continuous research."

Das's Institute was conceived with such modifications which Indian conditions imposed, on the lines of the British Leather Manufacturers' Research Institute, London. The location of such an Institute should be one where modern leather industry had made appreciable progress and where there was a University and an atmosphere of scientific research. Madras, having fulfilled these requirements was chosen the location for CLRI.

Strong Internal factors - scientific, technological and industrial compulsions - coupled with an external factor viz. the economic necessity of putting on modern lines an industry with high potential for export, gave support to the formation of a commodity- oriented laboratory. Its location in a centre where export of the commodity (although not in desirable quantities and values) was already evident and a strong technology-oriented higher educational institution (AC College of Technology- offering post-graduate degree courses in chemical, textile and leather technologies) coming up in association with the national laboratory, was a major plus point in its establishment.

The second Reviewing Committee (1954) acknowledged these factors thus:
"There is no doubt that this Institute is doing a fine job of work and will have a direct effect on the development of India's leather industry, both in regard to its cottage and large scale working. **It seems very well integrated with the industry which it serves".**

A decade later the Third Reviewing Committee noted thus:

"This valuable Institute has close links with the leather tanning industry in both towns and villages........The extension services of the Institute are doing an excellent job. The Director has experimented vigorously with some novel techniques of drawing the industry close to research with obvious success.

He has also shown initiative in orienting research to solve export promotion since the commodity is a major foreign exchange earner. Forward thinking regarding the future of leather industry and its research requirements finds a place in its future programmes.

The institute is fortunate in having cordial relations with its neighbouring university departments".

The committee was paying tributes, justifiably though, to the efforts of Nayudamma, the then Director, CLRI who went on to become DGSIR later. He joined CLRI in the early fifties and took over the Directorship of the Institute in 1958. Till 1971 when he was appointed the Director General of CSIR Nayudamma guided the destinies of an institute created in the centre of the leather industry in the South. The success he achieved in elevating the institute at Madras to an international level was attended by such innovations as the tanners' get-together (continued even today as Leather Research Industry Get-together or LERIG), leather fair, fashion parade, leather club, start-up of an industry based on R&D -- innovations designed to getting the industry interested in what he and his colleagues were up to and enticing it to take them in as partners of progress. A smart slogan he invented to win friends and influence people of the industry was - 'losses we take, profits you keep'. He understood **the essence of industrial research to be doing what the industry demanded** and to generate that demand he placed at its disposal all his wares.

"The presupposition in the effective collaboration of industry and research is the creation of the common culture. It involves breaking of the limits imposed by industry's self identification as industry and of research's self identification as research. The research worker in a field of applied research must see his own research situation with the eyes of both the industrialist and the research worker. The same is true for the industrialist. Each must become more than he has conventionally been. An extension of consciousness is necessary" (Y. Nayudamma). Analyzing how they succeeded in industrial research, P.S. Venkatachalam, a long-time associate of Nayudamma, states:

"Quick to realize that the EI (East India) Industry was the most powerful sector......... he cultivated the EI tanners assiduously.

All the initial research efforts were directed to rationalizing EI tanning and the dressing of EI leather"

"Realizing that extension work was the key to transferring research results, he gave special attention to this fact ..... One of the best technologists was put in charge of this wing and nearly 30 per cent of the institute's budget was allocated to this activity. More than anything else, this alone helped to build the image of the institute. On the fundamental side he gave a lot of encouragement for biopolymer research as he felt that ultimately polymers would have to supplement and complement leather"

The importance of university interaction in all these efforts at CLRI was not lost sight of. Nayudamma believed in the development pattern centred around man, that resourcefulness of man becomes the best resource and education is the source for developing this resource. He had a clear perception of what constitutes industrial research **'Interaction of trinity, -- Industry, university, government --is a sine qua non for success in any project'.**

Nayudamma and his men continued their interaction with the leather industry for over a decade. The processes transferred (in the beginning years free of charge) transformed the leather industry from an ancient, craft-dominated activity into a modern technology-driven industry with a large multiplier effect. The export value of leather and leather products was rupees 5000 million in 1980; it rose to Rs.25000 million by 1990 (see graph).

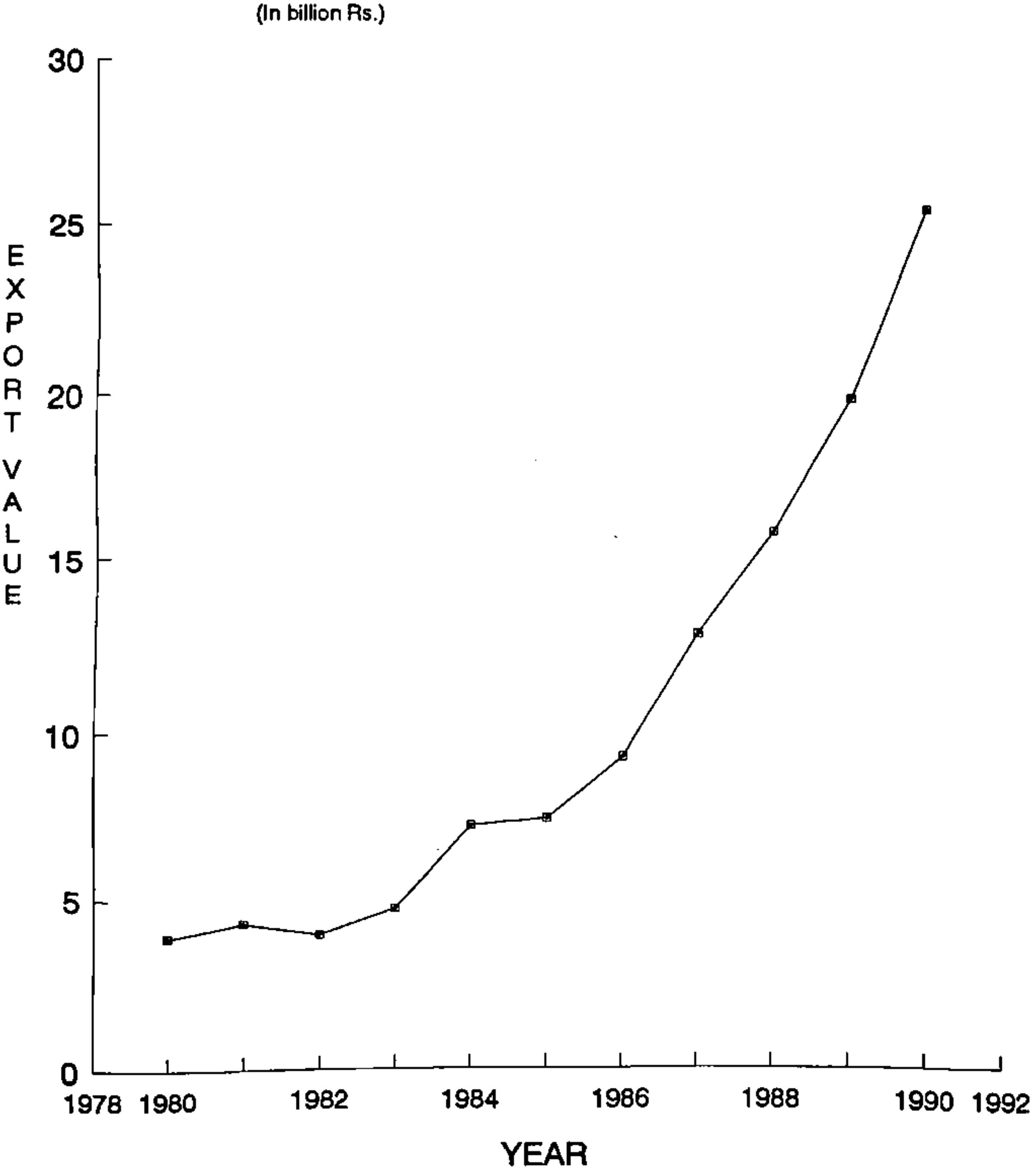
Today the industry is quite modernized and in terms of process technology is almost well up to world standards.

Now comes the question - how has CLRI reoriented itself to changing conditions? Is there still so much research to be undertaken on leather per se?. Other questions are - what about upgrading Indian raw material? How do we create a strong engineering base so that more and more machines are manufactured in this country? If vegetable tanned leathers can be made totally water-resistant and water-proof can they be not utilized for a wide range of leather products, including garments? Will this also not lead to cleaner technologies?

Some of the answers are to be found in the recent biennial report (1988-90) of CLRI and a paper on 'Perspectives for the future growth of Leather Chemical Sector' by T.Ramasami.

The Institute recognizes the opportunity to increase the share in international trade on leather and leather products with growing values for leather products. The Indian Leather

INDIA'S EXPORT OF LEATHER AND LEATHER PRODUCTS DURING 1980 - 1990



Source: Ramasami T.,

Industry, bitten by the modernization bug, has an ambitious plan of increasing its export earnings to Rs.60,000 million by the end of the Eighth Plan (1992-97).

CLRI has identified the following as priority areas.

- Resource and waste management
- Cost reduction and leather upgradation
- Better response from rural leathers
- Pollution abatement, and
- Newer designs and technologies for leather products.

Ramasami argues in favour of increased R&D activity in the case of leather chemicals. One reason is 10-20 per cent of the final sale value of leather constitutes the cost of chemical inputs. With more than 70 per cent of the leather produced in the country being exported, the supporting Indian leather chemical industry, mature as it is, demands better attention.

Ramasami estimates that by the year 2000 AD the demand for leather chemicals will exceed 1.13 lakh tonnes; of this, tanning agents and fatliquors will account for about 82 per cent. A SWOT analysis of the Indian Leather Chemicals Industry reveals that the opportunities and strengths justify intense involvement of a research institute such as CLRI. The competitive edge has also to be maintained. It has also been noted that the far eastern countries (Taiwan, a major importer) and the middle east countries imported in 1986 leather chemicals valued at over US $ 700 million. Thus a need for the University - CLRI- leather chemical industry to interact among each other and build a strong indigenous technology base has been stressed and appreciated.

Already a list of technologies had been identified in collaboration with the leather chemicals manufacturers' association.

"Therefore, it is not correct to say we have swerved away from the main path of concern about leather", says Ramasami. "By the time we obtain leather in its finished condition, we will have lost a good 40 per cent as waste. Lot of work needs to be done to minimize this waste and we will do it", says he. Dr. Thyagarajan the present Director observes- we must be alive to the changing environment in the industry internally and globally. We should also convert present day's threats into future opportunities, particularly in relation to the new Industrial Policy.

The Institute, having started as a research laboratory for leather in the fifties, has now turned the apex body on technical matters relating to leather. Its multifarious activities now include its functioning as

- the spokesman for the leather industry with technical institutions abroad
- the source of technical strength of the Indian Leather Industry
- the effective advisory group of the Government on policy matters
- the technical appraisal arm of the Government on import - export regulations, and
- the clearing house for technology information.

Thus CLRI is on the move to increase the intensity of its R&D investments by enlarging its scope of service to the Indian Leather Industry and the Government.

The questions: has it justified its existence and what benefits have accrued to the industry and at what cost are complex because costs and benefits are difficult to quantify. Even so, the questions have more or less been answered in the previous paragraphs.

A solid benefit, direct, as affirmed by Ramasami, that accrued to the Industry during the last nearly four decades is the continuous availability (a crop of half - a - dozen per annum) of leather technologists trained for and on behalf of the University of Madras by the scientists and technologists of CLRI.

Ramasami knows what he is talking about: he himself was so trained and is now training others. Designed that way this has been going on for over three decades now. Quite a number of these trained technologists now occupy vital positions in the Indian Leather Industry, translating their knowledge into ideas on products and processes. "I can confidently say that among other things responsible for the phenomenal growth of the industry during the last two decades the availability of technologists trained by CLRI is an important contribution", says Ramasami.

Secondly, thanks to the futuristic- oriented dynamism of Dr. Thyagarajan the Institute has acquired the following facilities recently

- Computer-Aided-Design (CAD) facility for design of footwear and a gait-analysis lab.
- a well - laid out multi purpose chemical process pilot plant
- a high - field (300 MHz) NMR

- on-line search for scientific literature and, as an infrastructure, a new auditorium with a seating capacity of 400.

With the above, the Institute has achieved the following

- synthetic fatliquors developed at CLRI and produced by industry met 60-65 per cent of national needs.
- it has proved its capability to provide a complete engineering backup in the modernisation of tanneries (already a tannery in Madras has become the beneficiary)
- it took a leading role in implementation of environmental technological options to the leather sector and increased the service network to more than 200 tanners.
- it enhanced its role as an international training house by offering training to 114 foreign students.

A corollary to the reasoning below has provided further fillip to CLRI in its search for the new horizons:

In addition to leather per se, the laboratory must pay attention to the other elements that constitute and contribute to the making of leather and leather goods and the development of the industry in general.

The kind of expertise available and built over the years must be provided an outlet so that it is utilised in an integrated manner within the overall perspective of industrial development in general and leather industry in particular.

Arising out of the first the institute has taken upon itself the task of upscaling laboratory processes in its pilot plant in collaboration with a possible entrepreneur.

(Synthetic tanning agents - ALCROTAN, ALUTAN, TUFTAN - and fatliquors were in this category). The industry (Balmer Lawrie is a recent collaborator) is quite happy with this arrangement.

The next reasoning has given rise to two scientific groups to emerge,the first a cell for industrial safety and risk analysis (CISRA) and the other a strong NMR - based team for basic work.

Since 1988, CISRA has been engaged in assignments in maximum credible accident (MCA) analysis, sponsored by the public and private sector industries. The NMR group has been making steady progress in building capability and making its mark in the international scene. It is now looking towards undertaking work in NMR - imaging, for possible industrial and medical applications.

Assuming that there were no CLRI at all, and now the industry wanted to establish one with the above capability, infrastructure and expertise, it is easy to perceive that the direct cost of the physical facilities (not accounting for land and buildings) will run up to a few millions of rupees. And it will be impossible to calculate the lead time by when such a new Laboratory will be able to offer its services at the level they are being offered now. The annual running cost of CLRI now is approximately Rs. 35 million. If all these are taken together it is obvious that industry cannot afford the price. Yet, the benefits as have been enumerated far outweigh the cost which went into making the institute what it is today. After all, it is recognised that among the costs have to be included the intellectual contributions made by a large number of scientists and technologists of the institute over so many years. This one factor cannot be estimated in Rupee terms; in any case it is invaluable.

Thus from the points of view of the background factors responsible for its establishment, its post-establishment contributions to the industry and benefits that have accrued, as contrasted with the cost that had gone into its making, here is a national laboratory that has justified its existence as a viable industrial research laboratory well recognised by the industry at home and abroad.

A profile of the laboratory is appended.

RRL-Trivandrum

Political initiative was an important external factor that led to the formation of the Regional Research Laboratory, Trivandrum.

In 1979, RRL Trivandrum was the latest to be established by CSIR. Actually the decision to call the CSIR holdings in Kerala as the Regional Research Laboratory was taken by the Governing Body only in 1978. Before that, they were dispersed in Cochin, Trichur and Trivandrum. The original idea started with the interest shown by the Chief Minister of Kerala the late Shri Achuta Menon.

After GB clearance, the laboratory started functioning in October 1975 under the name of the CSIR Trivandrum Complex. The state government transferred the Industrial Testing and Research Laboratory (ITRL) building along with all the equipment and two acres of land to

CSIR. Dr. B.L. Amla the then Director CFTRI Mysore was a member of the group that held discussions with the Chief Minister and other officials of the State Government. Later he became the Chairman of the expert committee for setting up RRL (Tvm.). Largely due to his sagacious outlook, the CFTRI experimental station located at Trichur and the Spices Research Division of CFTRI Mysore, were moved in stages thereafter and merged with RRL. Some members of ITRL were absorbed to form the nucleus of RRL strength. Dr. Amla was first named the Coordinating Director. He functioned as such till August 1977 when Prof. Pradeep K. Rohatgi took over as the Director of RRL, Trivandrum.

The major objective of CSIR activities in Kerala was understood to be provision of technological back-up to the industries in the region through R&D and technology transfer. Special emphasis was to be given to those problems which required inter-disciplinary inputs generally not available in other laboratories.

The major divisions of RRL, Trivandrum, during 1979-81 were food and spices, materials, and systems planning and research management, including technology forecasting and assessment (These were to be replicated in RRL, Bhopal, when Rohatgi went over there).

As was stated in its charter RRL started establishing strong links with the State Government of Kerala. This has continued till date.

The staff and infrastructural facilities grew steadily from 1977

Year	No. of Total Staff
1977	25
1978	80
1980	138

After Rohatgi's departure Dr AG Mathew functioned as the Acting Director till May 1985 when Dr. AD Damodaran took over.

Today its major divisions wherein R&D oriented to application of S&T for development of regional resources is undertaken deal with

(i) Plantation and bio-organic materials, and

(ii) clay, ilmenite and other inorganic - mineral materials

- Other concerns of RRL are: Basic aspects of chemistry/ physics/biochemistry/ materials science.

- value added products from primary materials (for commercialization) and
- pollution abatement measures related to processing.

RRL is also engaged in advanced research on materials, high temperature superconducting materials, photochemistry etc. The plantation materials under study are tree oil crops (palm and coconut), spices and tapioca. The present Director feels that RRL/Tvm., started as a Centre-State joint venture for working on regional problems, has performed satisfactorily. The motto is to follow the Louis Pasteur approach - "Look around, there will be enough S & T problems to work on."

Strong internal factors that contributed to the formation of this laboratory were- the policy of CSIR to provide its services in all states, the availability of the basic infrastructure in the form of a laboratory for spices (an important resource of the region) in Mysore, backed up by a service centre of food technology at Trichur and the willingness of different laboratories to pool their talent in Kerala. The external factors included the keenness of the State Government to participate in the setting up of the laboratory by readily agreeing to hand over an existing laboratory with whatever staff and equipment there were, the environment-- political, intellectual and social--prevalent in Kerala (a state with the highest percentage of literacy) and an enthusiastic scientist who, as the Director, was going to start new experiments in materials and systems research.

It should be noted that: RRL's at Trivandrum and Bhopal were born after considerable strain on the part of CSIR, Nayudamma was the head of CSIR and piloted the proposals in the beginning stages and the proposals were approved on the condition that **they were not to be known as RRL's.!**

RRL Bhopal

In the earlier Chapter we have seen how the proposal for the establishment of a laboratory in the State of Madhya Pradesh, in spite of its having been examined by more than one group of experts, did not fructify.

Consider the facts: the establishment was approved by the Governing Body, as early as in November 1976, with Nayudamma, the originator in a sense, in office as DGSIR. He left thereafter.

The government also changed and Dr. Ramachandran took over as DGSIR. The Planning Commission had not cleared the establishment of the laboratory in 1977-78.

In August 1978,in reply to a letter of July 1978, the then Prime Minister (Morarji Desai) wrote to the then Chief Minister of Madhya Pradesh (V.K. Saklecha) thus-

"The proposal is awaiting the clearance of the Planning Commission. I have asked the DGSIR to take steps to establish the laboratory as a new scheme of the CSIR Plan as early as possible"

Yes, the Prime Minister proposed, as it were, to let CSIR put up the laboratory but the Planning Commission disposed it of.

There was now a change of leadership in CSIR. Ramachandran left and Prof.M.G.K. Menon joined as DGSIR. Another Committee with Prof. B M Udgaonkar, Special Assistant to the Deputy Chairman of the Planning commission as the Chairman, the Directors of the Regional Research Laboratories of CSIR & the National Metallurgical Laboratory, Jamshedpur, and a representative of the Deptt. of Science and Technology, as members, was set up to go through the suggestion made in the original Project Report and those of Shri V.G. Rajadhyaksha, Member, Planning Commission, and make recommendations on the manner in which the laboratory should be set up.

One thing was clear by now: the laboratory -a fait accompli- should be set up; only the 'manner' was in question. The Committee, set up in March, met in September 1979 and finalized its report in March 1980.

The main recommendations were-

- there was a need for a laboratory in MP
- the focus of such a laboratory should be on rural and small-scale technologies based on local resources (agro; forest, mineral) but need not be narrowly confined to these.

The Committee was particular that the laboratory should have strong links with the State and Central Govt. agencies, the Khadi and Village Industries Commission (KVIC), the District Industrial Centres, (DICs) the Small Industries Service Institutes (SISIs) etc. and the universities and technical institutions in the State of Madhya Pradesh. Bhopal was also chosen the venue of the Laboratory.

It must be remembered that while approving the proposal in late 1976, the Governing Body had desired that the laboratory in Madhya Pradesh should not be known a Regional Research Laboratory.

In fact a draft note to GB had suggested the following alternative names.

Industrial Research Institute, MP

National Mineral Research Laboratory,

MP Madhya Pradesh Complex of CSIR because the laboratory could function as a CSIR Complex.

It now looks easier to identify why the laboratory was a non- starter in the year 1980. Nagpaul and Pruthi point out that in spite of the fact that (a) the Prime Minister evinced interest (b) the successive State Governments were keen (c) CSIR was ready and (d) three different committees recommended, the proposal could not go through, because the Planning Commission did not agree with the philosophy of setting up of regional laboratories.

It is interesting to note here that the late Dr. V.A Altekar, Director NML, Jamshedpur, one of the members of the Udgoankar Committee, had observed - "There is one disadvantage in Sri Rajadhyaksha's approach and that is the Government of Madhya Pradesh is deprived of a show-piece comprising magnificent buildings and pilot plants, etc".

Since the proposal was first considered way back in 1975, the Governments in the Centre and the State changed twice, two heads of CSIR left and a third took over, the Planning Commission was being overhauled and the political environment underwent change during 1977-79. All these factors acted as inhibitors to growth.

It was not until 1981 that the semblance of a laboratory did appear in Bhopal. And this came to pass because Prof. Pradeep K. Rohatgi, Director, Regional Research Laboratory, Trivandrum, was transferred to Bhopal. Actually he moved over to Bhopal in the second half of 1982.

In the Annual Report for 1983-84,Rohatgi claimed that "from a small strength of six personnel starting work at the library building of Bhopal University in 1981, the laboratory has grown to a staff of about fifty and is now housed in the newly constructed Cooperative Training College building Complex at Hoshangabad Road, Bhopal since December 1983. Modern facilities for materials preparation and characterization, including foundry, optical and scanning microscopes,Instron and other fibre testing equipment, testing of building materials and chemical characterization have started to function in full swing. A final lease deed for possession of 73 acres of land adjacent to the present campus, given by the MP Government to CSIR has also been signed".

True to the Report, the RRL organizational chart (in 1983) showed special divisions under the Director for mineral - based materials, forest and agro based materials and Systems Planning and Research Management which included technological forecasting (TF) and technology assessment (TA). He had, as a member of the Udgaonkar Committee, earlier proposed such a Software Group, particularly because he was then in the forefront in India, advocating TF and TA, having published a good deal on the subject.

CSIR had plans to purchase the building complex where the laboratory was housed. The housing units purchased by CSIR from the Bhopal Development Authority were allotted to the staff of RRL.

The Bhopal Gas tragedy in December 1984 dislocated normal life in Bhopal and slowed down the build up of infrastructural facilities of the laboratory.The then Director (Rohatgi) was on stretches of long leave during 1985 and until 1986, when his resignation was accepted by CSIR. This was the time the Abid Husain Committee was reviewing the activities of CSIR laboratories.

A new Director (Dr. Rajendra Kumar) joined RRL, Bhopal in December 1986. He came from NML, Jamshedpur. The activities of the laboratory were reorganized into the major disciplines of building materials, aluminium alloy technology including foundry, tribology, metallography, electrochemistry including surface coatings, natural, agro-forest, fibre polymer composites, minerals and ceramics, non-conventinal energy sources etc.

The Abid Husain Committee made the following recommendation on RRL, Bhopal-

"RRL Bhopal has yet to evolve at an adequate level. The CSIR should explore the possibility of the State Government taking it over and running it as a State Laboratory. Central Govt. assistance could be considered for its take over and operation for a limited period. If this is not possible, then it should be closed down".

This was part of the Committee's recommendations on redesignations,mergers and transfer of laboratories. It was going back to the mid-seventies when four laboratories were transferred to the user ministries and after experiencing hardships, came back to the CSIR - fold in the late seventies. CSIR had learnt some lessons of history, for, as later events proved, no laboratory, not even RRL Bhopal, was either transferred or closed down.

The Governing Body of CSIR did not agree with the Abid Husain Committee recommendation on the closure of RRL, Bhopal. In its February 1988 meeting the CSIR Society resolved:

"RRL, Bhopal has not yet evolved to an adequate level. The laboratory could serve a more useful purpose if it is linked to a Public Sector Unit in Bhopal,BHEL,for instance. CSIR is to take up with BHEL the question of take over of RRL Bhopal".

Take up it did. It appeared BHEL (Bharat Heavy Electricals Limited), was not very enthusiastic about the proposition. It was also noted, rightly though, that CSIR had the best experience of maintaining a multi-disciplinary R&D laboratory and if at all there was a future for RRL Bhopal it lay in its continuance under the CSIR umbrella.

This was effectively put across by Prof. CNR Rao in the meeting of the CSIR Society, with Rajiv Gandhi, PM, presiding, and it was resolved that RRL Bhopal continue with CSIR.

Thus was spared the axe on RRL Bhopal.

A new Director Prof. TC Rao took over in 1990. Like his predecessors he was also basically a metallurgist. His outlook, combined with the cooperation of the MP Government which acted as the catalyst, led to some remarkable upswelling in RRL's activities.

The Report for 1990 mentioned of a patent each in the USA and the UK for the manufacture of aluminium alloy graphite particulate composite using uncoated graphite particles for automobile and engineering applications. Seminars, lectures and get-togethers were revived. Infrastructural facilities for materials characterization, materials processing, infrared chemical analysis,metallography, foundry etc. were updated and sophisticated equipment like Atomic Absorption Spectrometer, Mozely Mineral Separator, Compensieve System etc. were acquired. A keen interaction with sponsoring agencies, government departments, industry and the academia helped the laboratory in fulfilling the objectives. The four research divisions of the Laboratory now deal with building materials, metallurgy and materials, minerals, resources development. The laboratory has established linkages with the Department of Mines, Ministry of Urban Development, MP Council of S & T, MP State Mining Corporation, ISRO, BHEL, Defence Metallurgical Research Laboratory, National Thermal Power Corporation, Hindustan Zinc Ltd., TISCO, CMC Ltd., Indian Bureau of Mines etc.

One of the catalysts for this look-up came in the form of the Director-General of the MP State Council of Science and Technology, Dr. DN Misra. He was, before he took over this position in 1989, the Head of the Extra-Mural Research (EMR) division of CSIR in New Delhi. Having been with CSIR for some time, he was fully aware of the potential of a national laboratory.

At Bhopal, he had the twin-task of reactivating the scientific departments of the State Government and a CSIR laboratory which was passing through a crisis. He rose to be the man to handle the crisis. It was the proof of the statement of Nayudamma "Send out your best men; they become your ambassadors". Misra, in addition to his duties with the State Government, also worked as the CSIR Ambassador, and was largely responsible for establishing the rapport that exists now between RRL and the State Government. He is one of the important factors for the resurgence of RRL, Bhopal, as a national laboratory.

The factors that originally went into the making of the laboratory could be traced to:-

1. Nayudamma's sense of anticipation (he knew it coming)
2. State Government's attitude to having a national laboratory in MP as evidenced by two Chief Ministers, Members of Parliament of the region and other politicians repeatedly appealing to the Prime Minister and others for setting up the laboratory.
3. An original well-laid out feasibility report which contained valid data (and reasons) on the rich forest and mineral resources of the region which could be tapped with relevant R&D.

Thus internal factors such as the policy of CSIR to reach the benefits of R&D to all over the country, the potential of industrial development of a comparatively backward State, as perceived by the scientists who analyzed it from different angles at different periods of time, the state of development of the region and external factors in the form of political support both at the state and the Central levels and the allround belief that the establishment of a national laboratory would set in motion scientific activity in the state and promote industrial development based on its natural resources, saw the birth of the laboratory. There was indeed a prolonged time interval between the decision to set it up and its actual start-up. The external decision-maker for the delay was the Planning Commission. Even after its birth, the laboratory went through successive spurts of activity followed by dips to dormancy, until another external factor in the form of a former CSIR scientist acted for and on behalf of the State Government as the catalyst in the blossoming of the laboratory. Political pressure was thus but one external factor in the creation of RRL Bhopal.

CCMB

In an unpublished study of decision making in CSIR hqrs. (1973) Nagpaul and Pruthi pointed out that CCMB had its origin to the old proposal of the establishment of a National Biological Laboratory.

It came initially from G N Ramachandran in his letter to the Director General of CSIR (Nayudamma) in 1973. There were two groups opposed to each other and differing on a number of issues. Two principal areas - cellular biology and molecular biology - were identified. Eminent biologists were consulted and it was concluded there was no need to set up a full-fledged national biological laboratory, but existing facilities of research in modern biology could be augmented. In a high powered committee meeting organized by the National Committee of Science & Technology (NCST) in which DGSIR was also present, it was confirmed there was no need to set up a new National Biological Laboratory. Of course, CSIR would go ahead with its own programme. It was then that the Regional Research Laboratory (RRL-H now known the Indian Institute of Chemical Technology - IICT, Hyderabad) came up (Sept.1974) with the proposal of setting up an autonomous Centre for Cellular and Molecular Biology. The Centre would actually evolve out of the then existing Biochemistry group, headed by Dr. P. M. Bhargava.

Now here is a case of a laboratory that demanded attention solely on the basis of the need for excellence in a modern area of Science. It was not to be, nor was it made out to be, a case of an industrial research laboratory. Consider the factors - modern biology was making progress in the world by leaps and bounds. If we were not going to make a beginning then, we would be far behind in the vital area of biotechnology, with possible applications in agriculture and medicine.

The objectives of the Centre (as per recommendations of the Talwar Committee - P M Bhargava being a member) were quite clear. They were to conduct research in modern biology and seek potential applications. Exploratory work (for biochemical and biotech applications), training, provision of facilities and interaction with other institutions were also envisaged.

The establishment of CCMB in 1977 fulfilled a long felt need in the country for providing the necessary thrust in molecular and cellular biology that are recognized as frontier areas in modern biology today. Discoveries in these areas have not only solved some of the problems on life processes, but have also found wide applications in agriculture, veterinary and medical sciences.

It has been claimed that CCMB is the first institution in India devoted exclusively for frontier area research in modern biology.

The principal internal factors for the establishment of CCMB were the conviction of DGSIR spurred by Advisers that excellence must be encouraged and the relentless pursuit of a goal by the proposer Dr. P M Bhargava, who went on to become the first Director of CCMB.

He was constantly on the go knocking at CSIR's doors for resources to achieve his ideal viz build a modern biological laboratory that would be at par with the best in the world. First he operated within the administrative confines of RRL(H). Later he proposed separate infrastructural facilities. The first meeting of the Research Advisory Council of CCMB in April 1980 (by which time he saw to it that CCMB had attained the status of a full fledged laboratory) was to consider staff proposals. A special note for the consideration of GB was put up in 1984, containing, among other things, annual reports of CCMB for 1982-83 and 1983-84 and the total construction plan of CCMB expected to cost about Rs. 80 million.

By way of fortification, Bhargava sent in a three - part article on the Excitement in Modern Biology which he wrote (along with Anita Gambir of CCMB) for the Indian Express (May July 1983). Therein he mentioned,

" As of today, at least two new institutions concerning basic biology which have promise of developing into Centres of Excellence- one in the process of being set up in the country - are the National Institute of Immunology in Delhi (later to be under Talwar) and the Centre for Cellular and Molecular Biology at Hyderabad. However, one of these institutions is yet to take off the ground and in the case of the other (CCMB), progress has been extremely slow."

He kept on complaining for quite some time. The annual reports of CCMB, since 1985, contained these expressions from its Head in the first few pages. In 1984-85 he confessed, 'I believe we have operated at no more than one third of our efficiency during the year.'

Yet behind all these grumblings, he was heading steadily towards the goal. And scientific work was progressing along lines charted in the objectives.

The subjects dealt with were - cell division, proteins, nucleic acids, ribonucleases, Micelles and membranes, osmoregulation, transcription, seminal plasma proteins etc.

In 1985-86, he declared - 'the policy of CCMB is to try to direct at least two - thirds of its research activities into new areas or new approaches towards solution of major problems, which would allow CCMB to be on the forefront of modern biological research at the international level'.

In 1987-88 the laboratory moved into its new premises; all the services in the new complex were made functional. In a carefully orchestrated move designed to attract the attention of the scientific community at home and abroad, Bhargava saw to it that the laboratory was dedicated to the cause of Science to the nation by the then Prime Minister Rajiv Gandhi.

Described variously as the best biology lab in the land (by admirers) and the 'five star laboratory in a poor country' (by detractors) CCMB continues its research work on the lines first drawn by the expert committee under Talwar. A recent addition to the laboratory is the DNA finger printing facility for possible forensic applications.

Thus was established a laboratory due to reasons that had for their base the very progress of Science.There was no doubt 'a champion' who fought for and succeeded in its establishment was around. It was a strategic move, considering we would have been without a CCMB, had not Bhargava pursued it vigorously.

TTRS

The Tower Testing Research Station (TTRS) was also established when Nayudamma was the Director General of CSIR. The proposal had to pass through rough weather from the beginning. The main party that proved an obstacle to its formation was the Central Electricity Authority and the Power Research Institute at Bangalore. What then saw the Station through was a combination of strong internal and external factors.

The strongest internal factor was the "champion" of the proposal Prof. GS Ramaswamy, the then Director of SERC, Madras. In spite of repeated arguments by the contenders against its formation the Director followed it up with relentless energy. For every argument against it, he came up with a couple of technical features that seemed attractive. Yet, DGSIR was constantly asking his hqrs advisers and Ramaswamy to make sure CSIR went ahead only if others wanted it to be taken up by CSIR. In fact, towards the close of 1976, Nayudamma recorded 'if not, drop it'. And he desired that it be conveyed to Ramaswamy. But by then the champion had left CSIR.

Now came a sudden twist in the proceedings in the form of a very strong external factor. The scheme was to receive UNDP aid, to the tune of about Rs 40 lakh. Even then Nayudamma wanted another technical scrutiny by the experts concerned. And then it was that the Tata Rao committee went into the matter and recommended the setting up of the Station at Madras. Another strong external factor that supported the establishment of TTRS was the interest evinced in the proposal by the tower manufacturing industry.

The Director of the laboratory claimed that the industry was looking for an advanced facility within the country and would make use of it in adequate measure. Combined with this external' factor was another 'internal' to the system viz the 'scientific curiosity' of the engineers and scientists of SERC wanting to use their acquired skills in a hitherto unexplored area i.e optimal design of towers and towerlike structures, making use of facilities comparable to what were available in advanced countries. That is one of the reasons why they chose to call it the Tower Testing & **Research** Station (TTRS).

Having thus identified the factors responsible for the establishment of these laboratories, one has to turn towards the all important question viz. have these laboratories - Scientific and Industrial Research in character - lived up to their objectives, in a broad sense?

In other words, how has the creation of these laboratories influenced or made an impact on the development of Indian industries over the years and how can one evaluate such an impact? These two questions are considered in the following chapter.

CHAPTER VII

THE CSIR LABORATORIES AND INDUSTRIAL DEVELOPMENT

At the time of the establishment of CSIR (in the early forties) the Indian Industry was in formative stages of development . Any development that took place did occur much after 1950, when the First Five Year Plan was launched. That was also the time when the first few industrial research laboratories of CSIR were established. It is, therefore, reasonable to expect that as the industries grew, so would the activities of the laboratories, more or less on a mutually reinforcing basis. In fact one of the factors responsible for the setting up of the first eleven laboratories, was the view that Industrial Development depended on (and would generate) the R&D work of these laboratories. The answer to the question - did it or not is not simple for the obvious reason that the government policy for industrial development did not for various economic / social/ political reasons depend on the programmes of the R&D laboratories. Even so in different sectors, Science, through many scientific agencies/departments/ institutions, specifically created for various reasons, did contribute to national development.

We have the cases of the Surveys -- Geological, Botanical, Zoological, etc., started even during the British times. Enormous quantity of data were analyzed and information brought out for the setting up of industries. Then were created the specialized agencies for agriculture, atomic energy, medicine, space and CSIR. While all of them had distinct objectives to fulfil and specific functions to perform, CSIR alone, with its network of laboratories throughout the country, was expected to contribute to the industrial development of the country.

The objectives for which CSIR was established spell out:-

- promotion, guidance and coordination of scientific and industrial research in India, including the institution and financing of specific researches.
- utilization of the results of researches conducted under the auspices of the Council towards the development of industries in the country.

CSIR has been assigned, and over the past, taken on, a broad range of activities of relevance to national development. The primary objective of CSIR is, of course, to establish a base of scientific capability and excellence, over a wide spectrum of science and technology to enable it to carry out research of value for the development of industries as well as other sectors of economy. Having established such a base to a significant extent, CSIR has used it to provide national standards, testing facilities, consultancy services and the undertaking of sponsored research, production of papers, monographs, technical and feasibility reports carrying out evaluation studies and offering advice to government and industry, popularization of science and publication of scientific journals, support for the promotion of scientific research in the form of award of Fellowships, operation of the Scientists' Pool, support to seminars and conferences, providing technical assistance to the developing countries, apart from generation of knowhow which is patented and made available for commercial exploitation.

There may be an impression that the entire activity of CSIR relates only to the last mentioned aspect which is measured in terms of premia and royalties earned. This, as can be seen from what has been said, is not the case and CSIR renders wide ranging services to support the national infrastructure in achieving self-reliance.

There were some in-built limitations on the extent of influence that government-funded laboratories could exercise on the way Indian Industries grew. Added to them were the changing policies of the government, in part protectionist and for the major part permitting of import of foreign technologies, because of which the Indian Industries did not much depend on indigenous technologies. According to Nayar "in pursuit of the programme of industrialization as a base for national independence, India adopted the strategy of "selective disengagement" from the international economic system through a massive import substitution project as also the diversification of trade. At the same time, the country relied on foreign technology and foreign credits to achieve its import substitution goals; a broadfront licensing strategy was employed for the import of technology.

Thus there seemed to be a distinction between the long-term strategic goal of economic independence and the short-term tactic of reliance on foreign technology and, in part, foreign credits. By and large the technology import was directed at the sectors given priority, but there was also indiscriminate and repetitive licensing and often in packaged form.

Actually during the Second and Third Plan periods (1956-65), there were major industrial changes. Industrial production doubled and indigenous technology was understood to have potential.

How did indigenous technology, whatever was there, fare in comparison with imported technology? Some case studies in this regard were taken up (including one related to production of tractors) by Ashok V Desai who concludes "This element of indigenous innovation is characteristic of a number of market leaders in India. Some of them built on the basis of imported technologies; others did not. None of them made such major innovations as to establish a large and stable export market.

The level of originality in most cases is low: the achievement generally has been to produce a cheap, sturdy, reliable product suited to the Indian market " Further," our impression based on market structures and technology sources was that whilst technology imports on their own tended to create oligopolistic market structures, R&D reinforced the competitive advantage of large firms. But the leakage of technology within the country had led to the emergence of many small firms, and they had appreciably increased their market shares in many differentiated large group industries.

It is also difficult to agree with Desai's statement that "import restrictions on technology do not produce import replacing technology". There are two distinct cases where CSIR laboratories have disproved the above contention. One was the import restriction placed on pesticides. The CSIR laboratories over a given timeframe came out with indigenous technologies for pesticides and now there are virtually no imports. The second case pertained to optical glass for Defence use. Even today a pilot plant at CGCRI produces the material. Further the restriction on export of raw hides and skins and later semi- finished leather helped the dissemination and transfer of several indigenous technologies of leather processing by CLRI. This brought about a significant transformation in the Indian leather industry. As a matter of fact the Indian leather industry has reached the present stage of huge exports of finished leather and leather goods due to government policies and relevant R&D at CLRI.

There are of course several sectors which grew - and grew well indeed - in spite of the industrial research laboratories. But then the reasons for the lack of impact of R&D on Indian industry cannot be traced to the functioning of CSIR laboratories alone.

As has been pointed out, "............ in economic terms, research directly produces **only technical opportunities to exploit** (sic), not the results of such exploitation. Proper exploitation of these opportunities by remainder of the enterprise creates the actual economic yields of sales, profits, cost savings, royalties etc., i.e. the indirect products of research." (James Brian Quinn).

Moreover, the idea of self-reliance in Science and Technology was to build up an industrial structure based on imported technology and foster it with the establishment of a strong S&T base, which would take care of further development.

There was a flaw in this model . "In building CSIR as a general purpose R&D organization, not much thought was given to establishing effective linkage between research and industry. But this neglect resulted from the assumption among decision makers that there will be an automatic translation of scientific research into industrial use once the R&D infrastructure was in place. In this the decision - makers shared the general ethos of the era in which they lived". (Nayar).

This view has been further expanded when Nayar spoke in defence of CSIR 'There seems to be an underlying expectation, at times unstated, that the CSIR should have enabled India to industrialize on the basis of indigenously developed technology, or that even now it should make it possible for the country to ban the entry of foreign technology and provide the substitutes for it from within. One must, however, question the realism of such a proposition notwithstanding the underlying desire for technological self-reliance'.

The laboratories of CSIR have contributed substantially to the growth of the Indian industries - all of which cannot be quantified. Additionally, the industries also undertook their own R&D. More and more projects were sponsored by the industries in the CSIR laboratories. This situation leads Nayar to conclude that 'Science now is an investment not a consumption good.'

It is not as though the Government were not seized of these problems. In fact, from 1948 onwards, the Scientific Advisory Committee to the Cabinet (SACC) has had several incarnations. Yet, the gap between laboratory research and industry persisted. It has been observed - "The basic reason for the supply side of S&T - laboratory R&D - not having the desired impact on development has never been squarely addressed. That is, how to articulate the policies of the demand side, which rests with the economic ministries of industry, commerce and other socio-economic ministries, so that they exercise pull on endogenous S&T inputs. Until and unless the apex advisory body acquires the necessary leverage to do that, the gap between laboratory R&D and industry will, in fact, only widen further." (Ramachandran, R.).

There has been a change in the recent past. The government has announced a new industrial policy. Consequent on this, imports have been liberalized. Indigenous technology has to face fierce competition at the global level. Added to that is the resource crunch declared by the government forcing the CSIR laboratories to go all out for external cashflow, particularly from the private sector. **Now the real test begins.**

Evaluation of Performance of Laboratories

As has been stated in the previous paragraphs, evaluation of the performance of CSIR as a whole or finding an answer to the question how effectively have the laboratories contributed to the development of the Indian industries, has to be approached in the context of several other criteria which are independent of what the laboratories are expected to do.

Moreover the laboratories perform several functions directed at sectors which may or may not be linked to industrial development. Such functions have also to be considered as research output worthy of note. How does one measure the research output (RO) of a laboratory in order to evaluate its performance?

The concept of RO has been generally extensively discussed and attempts have been made to evolve acceptable criteria. What have, however been accepted are such notions as the uncertainty of R&D, the intangible nature of measurement of research output, and the difficulty in working out input - output ratios, there being no uniform method of measurement of inputs either. It is also felt that evaluation of research has to be undertaken against a set of objectives to be achieved and in this process, quite a large amount of subjectivity enters. Subjectivity criteria do play an important role in measurement of Research Output.

What is needed probably is a combination of subjective and objective criteria, depending on the sample available. In the Indian context, particulary in the case of a CSIR laboratory, this seems to be in order. One method of evaluation is discussed here.

The basis of evaluation proposed is the categorization of important functions of a laboratory thus:-

A to do advanced research, basic and applied, with a view to contributing to advancement of knowledge.

Usually, this results in the publication of papers, patents, reports, drawings etc.

B to develop and transfer technologies and see that they are commercialized. Technology transfers do normally entail payment by the transferee (royalties, premia lumpsum, etc.)

C to provide services to industries, other government departments/agencies/public sector enterprises and universities (services of sophisticated nature not easily obtained elsewhere in the country) - These are usually paid for.

D to win peer recognition/awards, honours, institutional or individual.

The Reports of the laboratories contain qualitative appraisals (some quantitative, particularly regarding B and C) of the above criteria. There has not hitherto been any quantitative estimation of all the criteria taken together.

Is a quantitative estimation of all the criteria possible?. There seems to be a need, particulary because since 1986 when the Abid Husain Committee recommendations were accepted it has become incumbent on the part of the laboratories to earn a third of their expenditure. The factor will have to go up to 40 per cent by 1995.

Laboratories, willy-nilly, have to cross that mark very soon because of recent developments such as the New industrial and liberalized Trade Policies announced by the government and the inescapable resource-crunch that goes with it. The accent is more on development of technology with an eye on the cashflow from non- governmental sources. Already some of the laboratories like NCL and IICT have set their sights on producing globally competitive technologies (in catalysis, drugs) and earn the much-needed foreign exchange.

A quantitative estimation of each of the above criteria will lead one to arrive at an empirical relationship correlating Performance (P) to a sum of all the criteria. Assigning values to each of the criteria (depending on emphasis of activities etc) one can possibly work on a relationship such as $P=\alpha A+ \beta B+\gamma C+\delta D$ where α,β,γ and δ are relative weights attached to each of the criteria.

This has not yet been systematically analyzed, mainly because of definitional inconsistencies and lack of data.

What has, however, been done is the analysis of RO purely on the basis of A i.e. the research papers published by the laboratories during a year. For this purpose, the output has been defined as the contributions made by scientists of laboratories in the form of papers published in journals, papers presented at conferences, monographs, chapters in books/monographs, patents and reports. The approach is bibliometric as distinct from quality assessment through peer review.

The basis is the Science Citation Index (SCI) first brought out in 1963 by Eugene Garfield.

The impact factor (IF) of a journal has been defined as the ratio of total number of citations received by it to the number of citable items published in it during a fixed period. For example, if a journal has received 20 citations in 1991-92 and it published 100 citable items during the same period, IF of this journal in 1993 is 0.2. IF of a journal changes from year to year.

The impact factors of periodicals are published in the Journal Citation Report (JCR) every year and it forms part of SCI. The periodicals covered in JCR are core periodicals and internationally recognized in their fields. They are also refereed. The quality of papers published in them is assured through a screening system adopted by their editorial boards and generally the rejection rate is high. (Research Output 1987).

For 1991 the impact factors of the journals were taken from the Journal Citation Report 1990. About 35 per cent of the papers covered in the analysis were published in journals not covered by the Journal Citation Report.

The impact factors of those journals which originated from India were determined according to a formula developed by the National Centre of Bibliometrics (at INSDOC, New Delhi) which has pioneered work in this area. In some cases some values were arbitrarily assigned, taking various factors into account. Journals which started publication in 1989 or later were assigned IF 0.000 as their impact had yet to be established.

The analysis was carried out (by Sen, Karanjai and Pandalai) taking both IF and normalized impact factor (NIF) into account. The IF of the topmost research periodical in a subject category was normalized to 10 using a suitable multiplier. Using the same multiplier the NIF of other periodicals figuring within the same subject category were determined.

For 1992 (dealing with publications of 1991) it was observed:

- the percentage of papers in SCI journals (i.e. Journals covered by Science Citation Index) has gradually increased since 1986, when bibliometric analysis in CSIR commenced;
- in all, 37 papers were published in 1991 in topmost journals of the world having NIF greater than or equal to 9;
- that 15 laboratories (NPL and NCL among them) have increased their output.

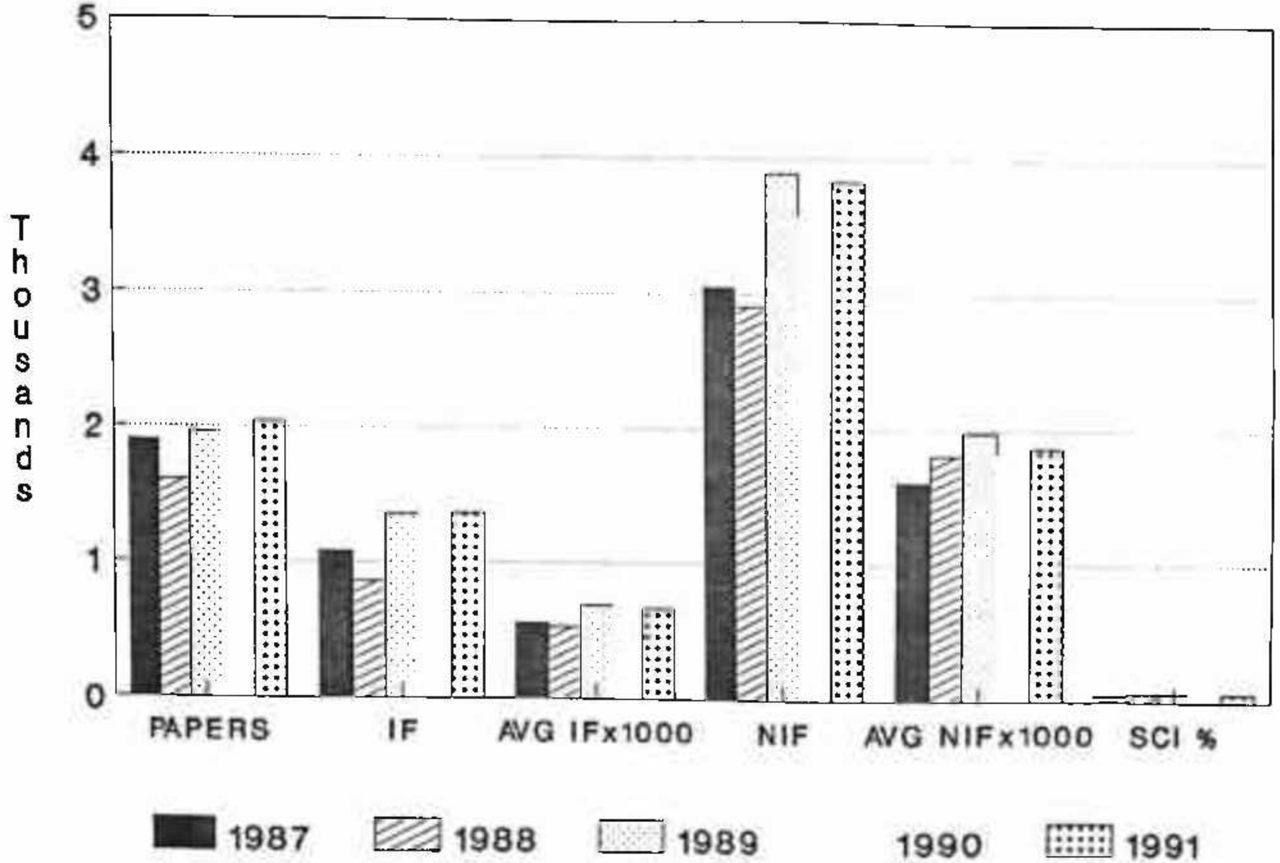
The enclosed tables give the laboratory-wise distribution of the research output for 1987-1991, for the six laboratories in view.

This technique, despite its limitations, has proved to be useful and is finding acceptance. It is accepted that this is not the only index of performance. But in the absence of other accepted techniques this has been accepted to be one of the several indices that constitute the overall evaluation of a laboratory.

The other indices can be gauged from the enclosed table on technologies transferred. The table speaks for itself.

CSIR INDICATORS

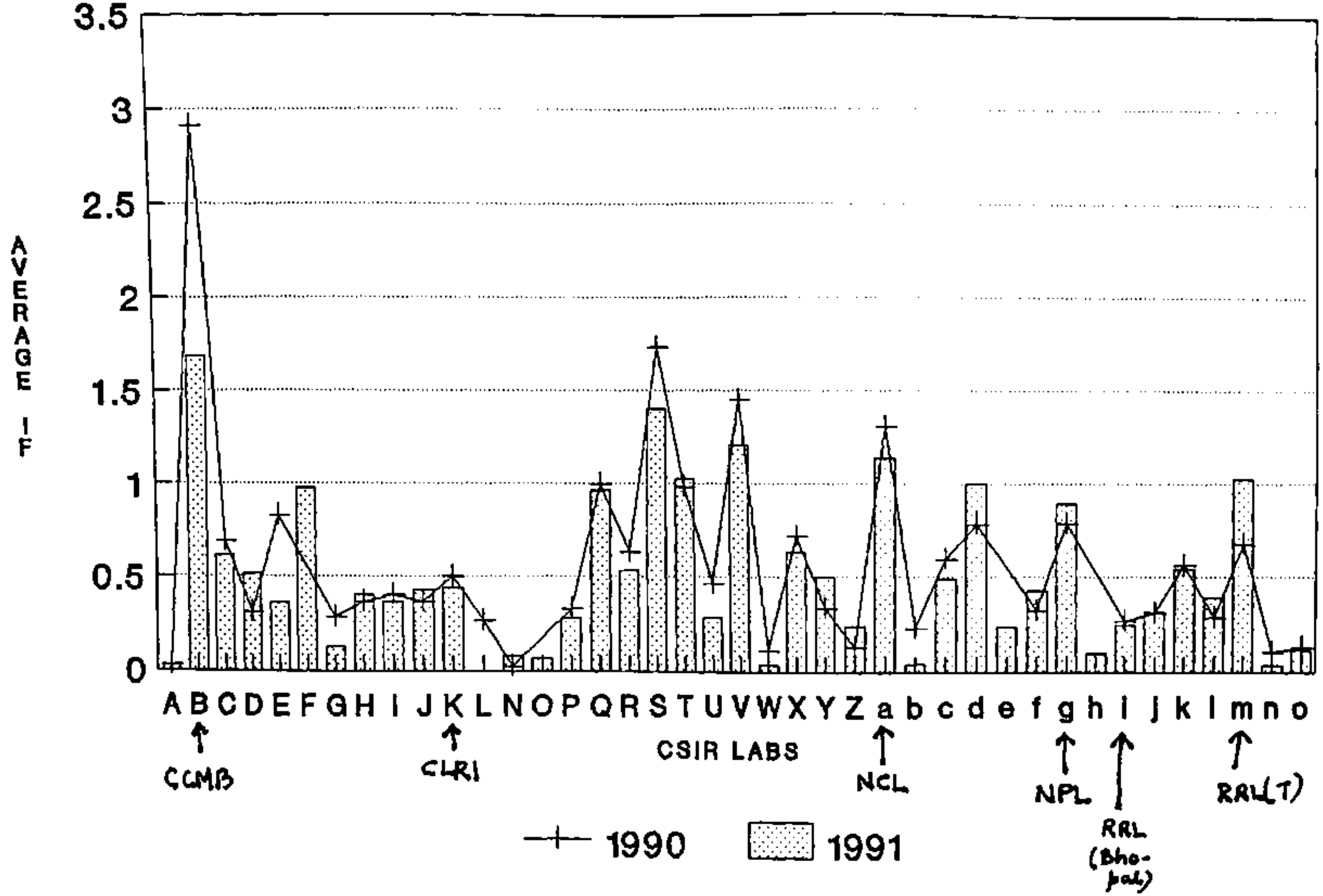
(1987-1991)



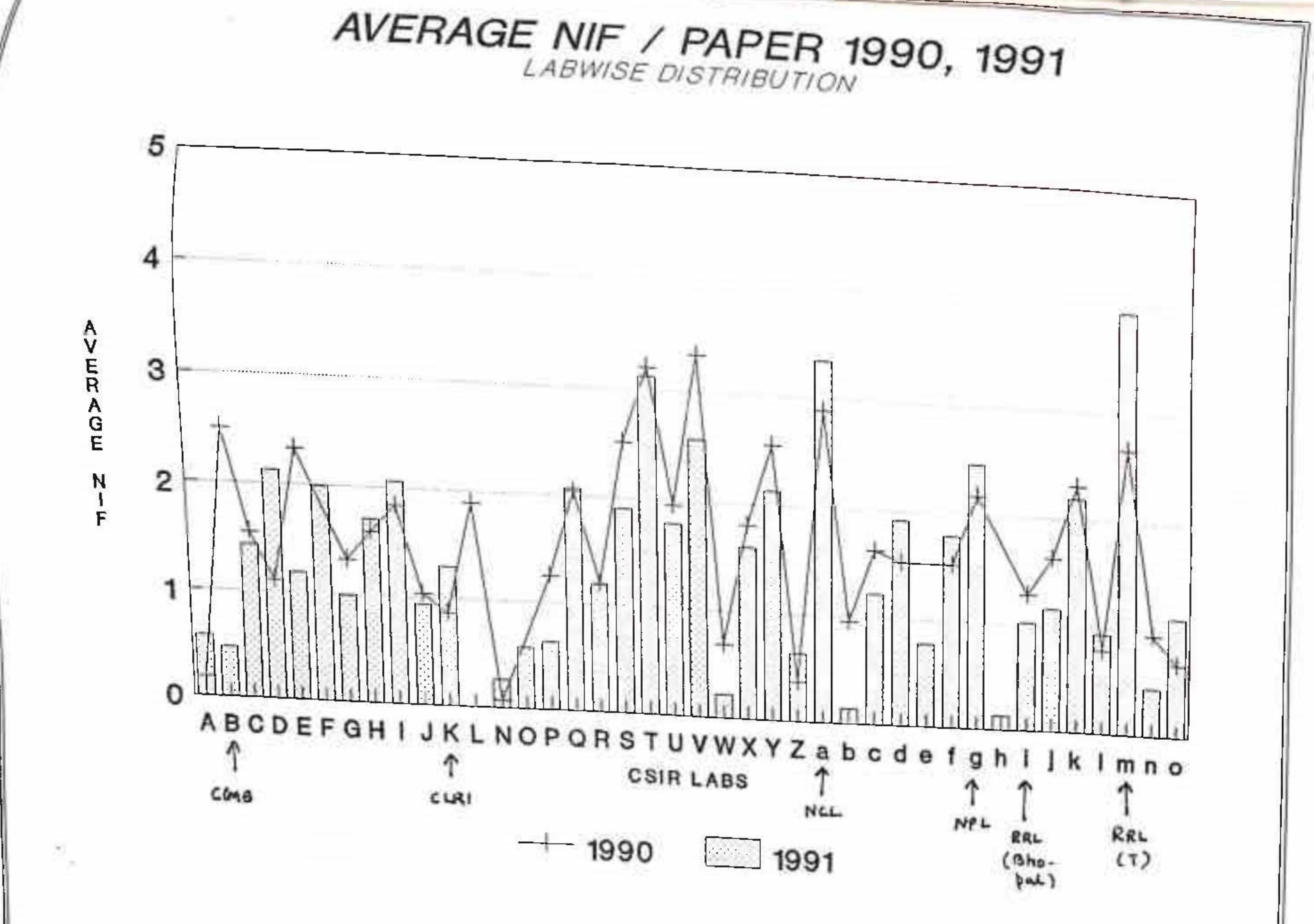
Source: CSIR Research Output-1991.

AVERAGE IF / PAPER 1990, 1991

LABWISE DISTRIBUTION



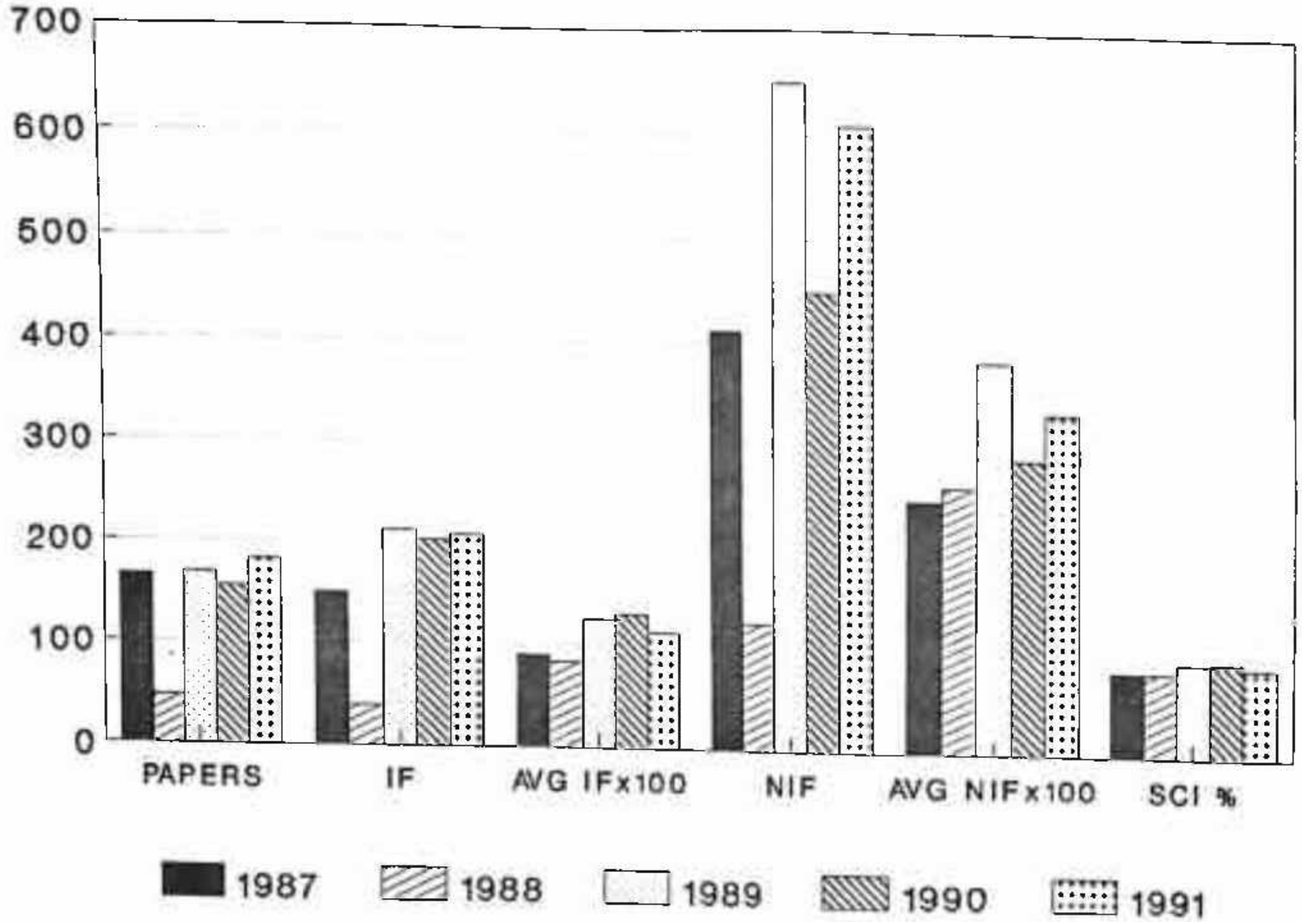
Source: CSIR Research Output-1991



Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-1991

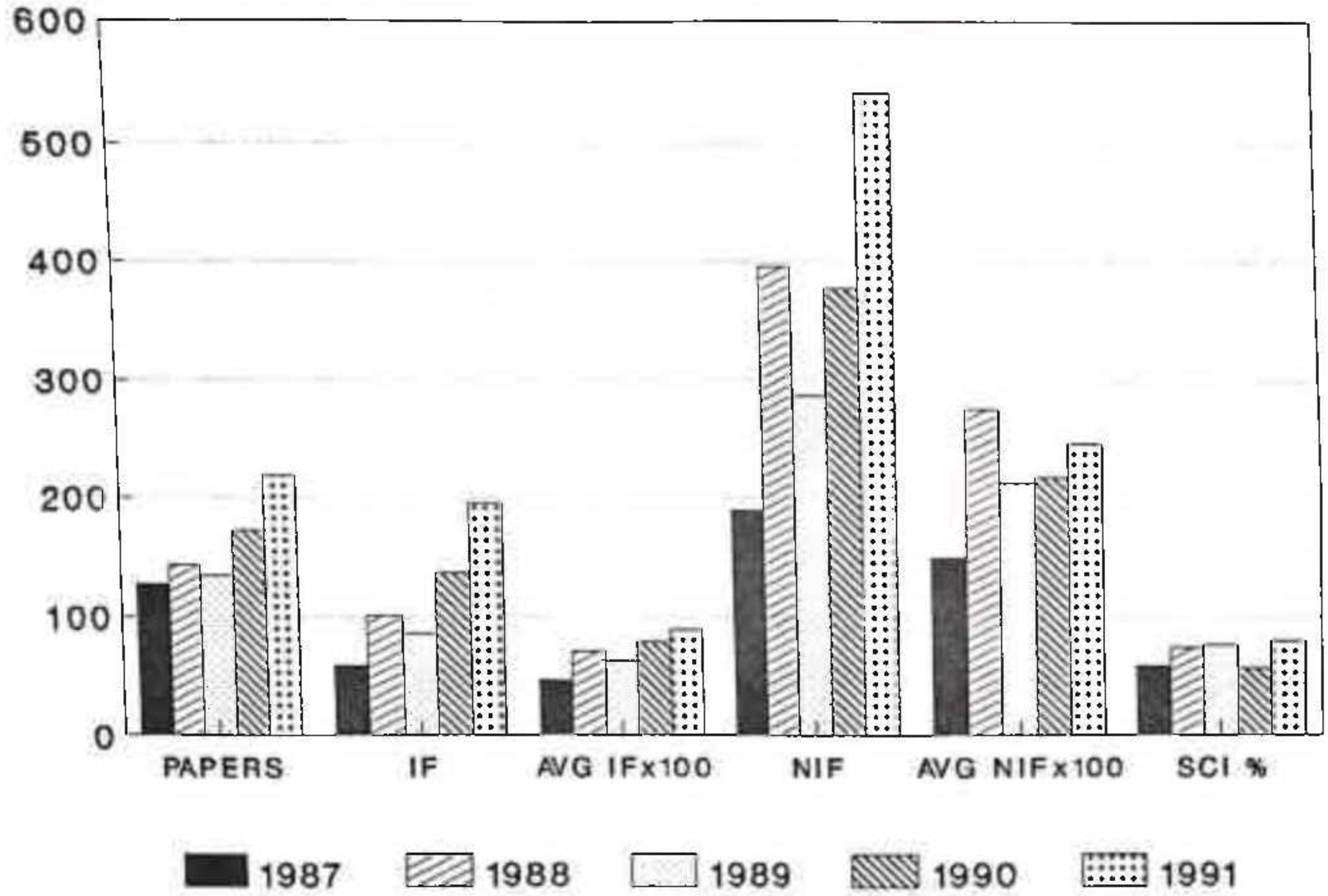
NCL



Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-1991

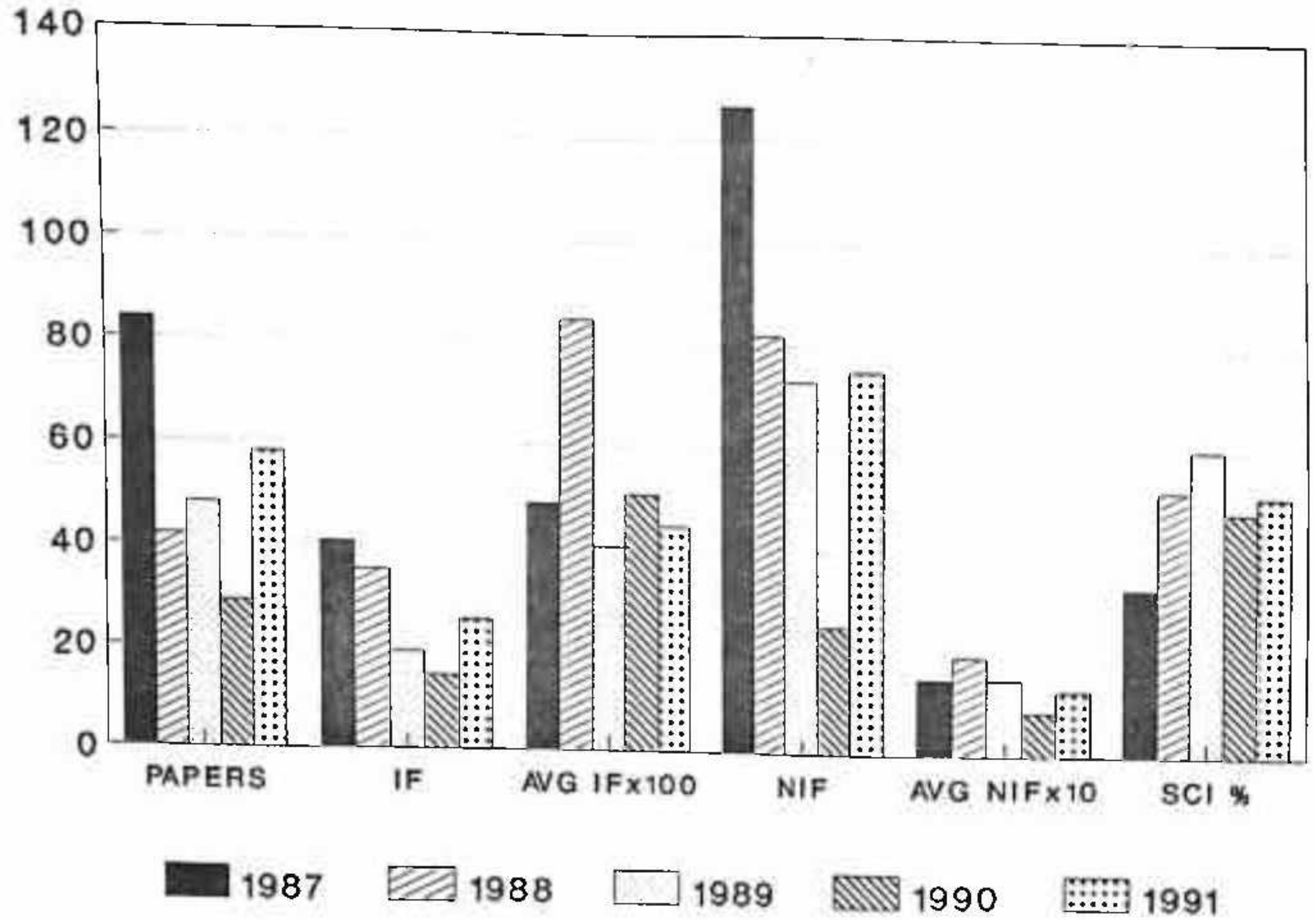
NPL



Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-1991

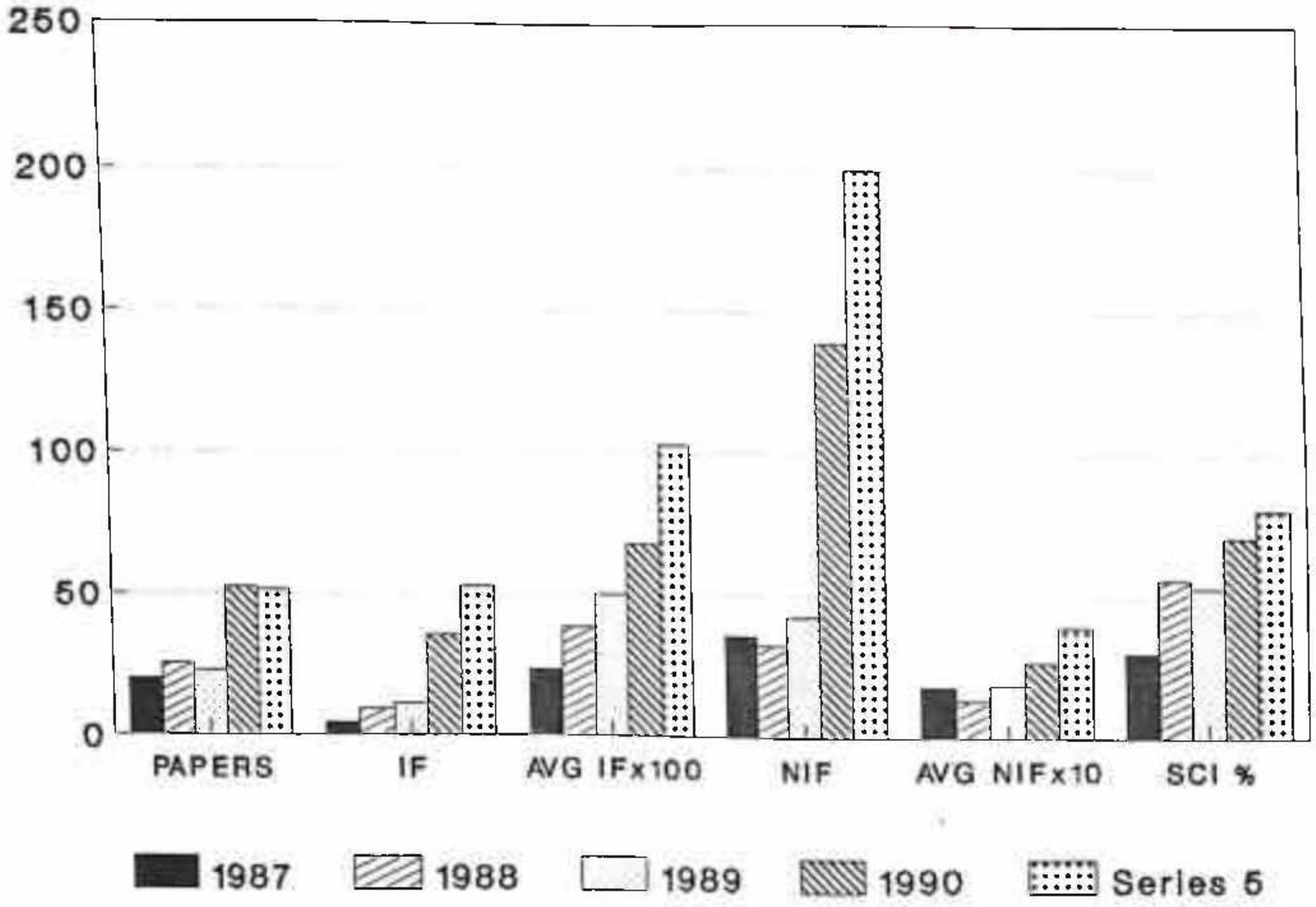
CLRI



Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-91

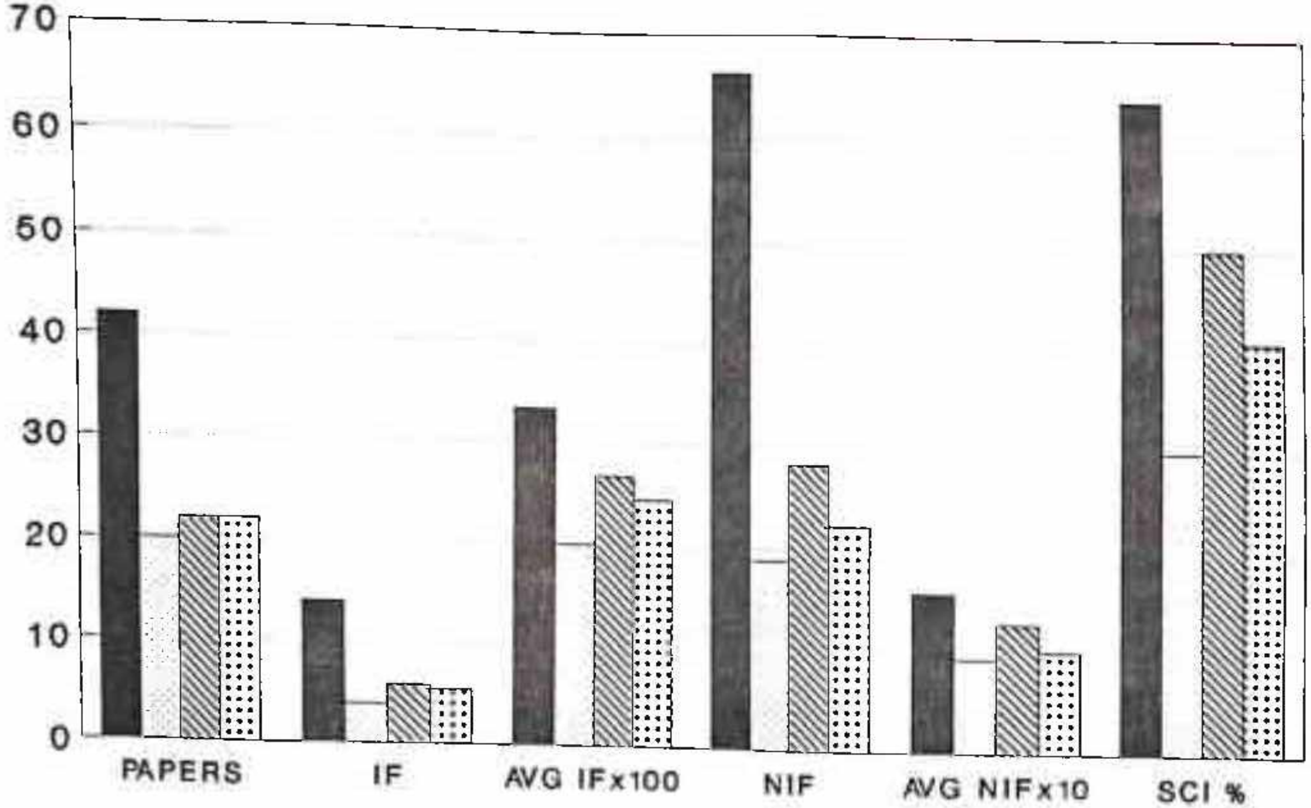
RRL (T)



Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-1991

RRL(B)

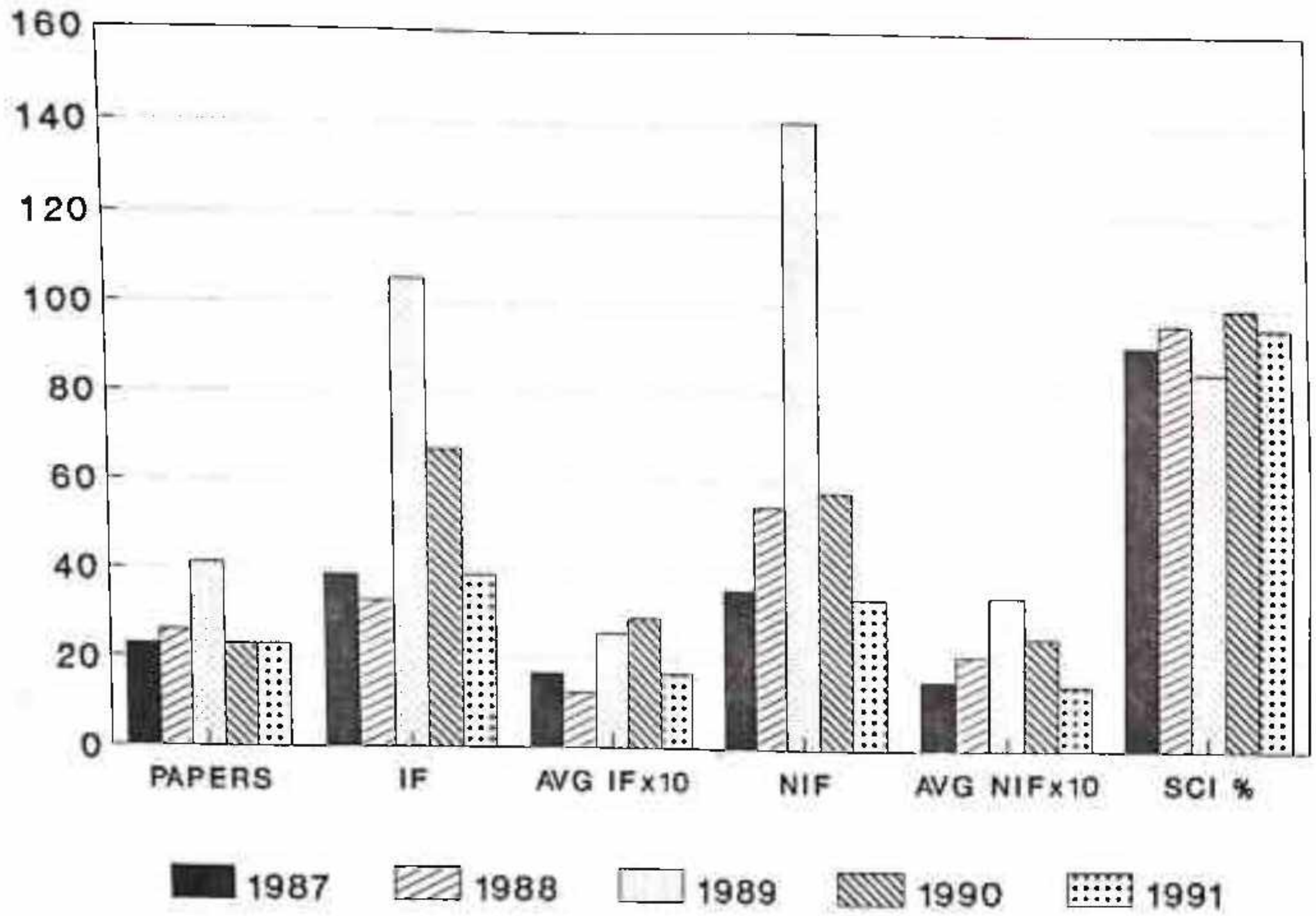


* No data received for 1988

Source: CSIR Research Output-1991

TRENDS OF RESEARCH OUTPUT 1987-1991

CCMB



Source: CSIR Research Output-1991

MAJOR TECHNOLOGIES/KNOWHOW DEVELOPED/LICENSED DURING SEVENTH PLAN (1985-90)

S. No. Technology/Knowhow	Lab	Special Features & Economic Impact
1. AGROCHEMICALS		
* Monocrotophos (broad spectrum insecticide) * DDVP (-do-) * Chloropyriphos (-do-) * Butachlor (rice weedicide) * Isoporturon (wheat weedicide) * Neem based insect anti-feedant * Pheromones for cotton pests etc. * n-Triacontanol (plant growth regulator)	IICT NCL RRL (TRI) CFTRI	- Production value Rs.80 crore / annum - Safe and environ-mentally clean pesticides - Process involves novel economical & safer routes - Additional capacity planned to yield a turnover or Rs. 70 crore.
2. DRUGS & PHARMACEUTICALS		
New Drugs * Centchroman-female contraceptive pill * Gugulipid - hypolipidaemic * Centbutindole - neuroleptic * Centbucridine - local anaesthetic	CDRI	- Production value Rs. 10 crore / annum - Novel drugs with no toxic effects - Processes use mostly indigenous raw materials. - Technology/product being exported to Europe & USA
Known Drugs * AZT - anti-AIDS * Etoposide - anti-cancer * S-Timolol - anti-glaucoma * S-Flurbiprofen -anti-in-flammatory/analgesic * Gemifibozil-anti-cholestaemic * Astemizole-anti-asthmatic, Vitamin B_6 * Vinblastine/vincristine-anti-cancer * Norfloxacin/Ciprofloxacin-anti-bacterials * D-Propoxyphene HCL- analgesic	IICT NCL	- Production value Rs. 50 crore / annum - Monopoly of foreign companies. - Manufactured for the first time in the country. - Processes use chiral synthesis thereby eliminating non-active & toxic isomers. - additional capacity planned with estimated production of Rs. 100 crore annually - Products/technology being exported
3. PETROLEUM REFINING AND PETROCHEMICALS * Benzene & toluene extraction * Food grade hexane * Ethylbenzene * o & p-Xylenes	IIP NCL	- State of art technologies - Establish Indian capabilities

S.No. Technology/Knowhow	Lab	Special Feature & Economic Impact
4. CATALYSTS * Alcohol to ethylbenzene * Mild hydrocracking and hydrodewaxing * Xylene isomerisation * Pt -Re bimetallic catalyst * Benzene to Cyclohexane	 NCL IICT IIP	- Production value Rs. 10 crore / annum - Novel catalysts - Substitution of imported catalysts - Establish Indian capability in closely held high tech area
5. CHEMICALS AND INTERMEDIATES * Sodium azide * Sodium silicate * Cyanoacrylate & anaerobic adhesives * Oil well drilling additives * Ranitidine	 IICT CGCRI RRL-JOR NCL	- Production value Rs. 10 crore / annum - Establish indigenous capability - Products being exported
6. BIOTECHNOLOGY * Alcohol fermentation * Agrotechnologies for cultivation and extraction of aromatic plants. * Tissue cultured economic, forest plants, and plantation crops. * Biomethanation of distillery spent wash * DNA Finger-print probe	 NCL IMT CIMAP NEERI CCMB	- Production value of Rs. 50 crore / annum - Plant tissue culture technique used to produce high yielding, disease resistant crops. - Gainful utilisation of wastes.
7. LEATHER & LEATHER CHEMICALS * Modernisation of tanneries: Microprocessor based control of tannery wet operations. * Speciality leathers / leather finishing techniques * High performance novel synthetic tanning agents alcrotan & alutan * Acryl soft binder	CLRI	- Automation in tanneries has resulted in saving of about Rs. 1 crore / annum - Production of leather chemicals and speciality leather of about Rs. 20 crore / annum - The processes and leather chemicals developed are environmentally safer, clean and more efficient than the existing chemicals/processes.

Inspite of such seemingly significant achievements of the CSIR laboratories(on almost all aspects of R&D in general and on contributions to advancement of knowledge and industrial growth, in particular), there had been continuing criticisms that the linkage between CSIR & Industry had not been as effective as it should have been. An unstated but implied point was that industrial research was not pervasive in the CSIR laboratories. "Laboratory research isolated from production as done by CSIR is less useful than innovation by manufacturing firms themselves; consequently Indian firms prefer to import technology from a producer abroad" (A.V. Desai).

Two aspects that need attention are: first, has there been a culture of industrial research in the country to have enabled, permitted and facilitated these laboratories to function effectively as industrial research laboratories; secondly, what has been the experience of industrially advanced countries, how did they succeed and how did India fare?

The first question takes us back in Time so that we can have a quick look at things in their historical perspective. Questions that need be asked are- what kind of a scientific outlook did the Indians of yore have, when did we, if at all, accord industrial research recognition in the general scheme of things?

Chapter VIII on Conclusions attempts to find answers to these questions.

CHAPTER VIII

CONCLUSIONS

A historical view of the development of Science in India is quite revealing. Leaving aside the pre-historic time, when we come to the Neolithic Age, we are struck with the remarkable phenomenon of the flourishing years of the Harappan Culture (circa 2000-1750 B.C.) in which there was evidence of the existence of copper- bronze technology, glazed pottery, agriculture etc. Between 1000 to 500 B.C., production and use of iron in open-hearth furnaces and casting of alloys were mastered by the ancient Indians.

Ajit Ram Verma (one-time Director of NPL, New Delhi) observes .... "there is a system which is very vital for quality of life, but is not so visible by itself. This is the measurement system of the country which in a way pervades all other systems, since it is needed for trade, commerce, industry, science and engineering and even in public affairs for taking decisions on a quantitative basis."

According to him, "India has had a tradition of excellent measurement system in the historical past. During the Indus Valley Civilization which flourished during 3000-2000 BC, there is a strong evidence to suggest that an unbelievably uniform system of weights and measures existed over an area of nearly 1500km x 1500km covering most of North West India. The Mohenjodaro Civilization shows the construction of buildings, wells and the use of bricks of rectangular shape, the length, width and height being in the ratio of 4:2:1. In construction, what is commonly called the "English Bond" system was utilized." This civilization disappeared; nothing further was known but legal metrology came to be in operation during the Maurya Empire (322-298 BC). Chanakya's Arthasastra laid down the principles of legal metrology.

'A comparative study of the Indian scientific thought with that of Europe shows', states Subbarayappa 'that while Europe was passing through the Dark Age from about the fifth to the eleventh centuries AD, India had her period of glory in the Classical Age and made remarkable progress in such fields as mathematics, astronomy, iatro-chemistry and metallurgy even right upto the twelfth century AD. Thereafter, the creative endeavour showed signs of decay due largely to the traditional compulsions and political vicissitudes.'

From the above, two things stand out. First, Indian Science was quite ancient and the spirit of inquiry was a part of the culture of the people. Secondly, technology whether or not independent of the growth of Science, played a significant role in the lives of the people. This is direct evidence to show that some activity of application of techniques and methods for the production of goods and services for the material well-being of the people and the enhancement of the standard of living, did take place. Also, this must have been related to the economic environment of the locality, where people lived. Hence there was an industry of sorts, though of scales not comparable to what are obtained now. But then, these activities died away.

From the western point of view, the growth of Science was linked to the periodic occurrence of wars between nations. J.D. Bernal, in his Social Function of Science states, "the great technical developments of the eighteenth and nineteenth centuries, particularly the large-scale smelting of iron by means of coal, and the introduction of the steam engine, were directly due to the needs of artillery which the increasingly large scale of war demanded." He seemed to have no doubt that science and warfare had always been most closely linked and 'it may be claimed that the majority of significant technical and scientific advances owe their origin directly to military or naval requirements.' (Note the title of 'military-industrial-complex' given to the USA in the post-war period and later).

Industrial Research, the beginnings

Industrial research was also an off-shoot of the War. The history of the dyestuff industry proves the point. The first synthetic dye was made in England by Perkins, but the industry soon got rooted in the German soil. Bayer's process for synthetic indigo, commercialized after research for a long time established the fact that industry in Germany was inclined to look for results of scientific research for application. Haber's process for synthesis of ammonia from nitrogen and hydrogen utilized by the Badische chemical engineers was another example. But the British waited long enough to become dependent on Germany for dyestuff. War aggravated the situation and the British Government had to take far-reaching steps. Sir J.C. Ghosh, in his opening address to a symposium on Post-War Organization of Scientific Research in India, held at Calcutta in September 1943, observed: "The conviction has now become universal that the nation, which will enjoy the benefits of science in the day-to-day progress of its industries and agriculture, is the nation which habitually applied to them scientific method and scientific knowledge: and it is that nation which will be able to seize the advantages of the more spectacular achievements of science in its economic life."

To go back a little in Time. In a succession of significant measures, the UK Department of Scientific and Industrial Research was established in 1916. This was followed by the founding of the National Physical Laboratory, the Geological Survey of Great Britain, the Fuel Research Board, research laboratories for buildings, roads, forest products etc. and industrial research associations. (Fox)

What followed in the UK and later in our country are well known. The need for industrial development, and therefore, scientific research (as has been learnt during and after the War years) was repeatedly stressed whenever there was an occasion for a public expression of views.

It was reported that in 1930, in connection with a proposal for India to join the International Research Council and its various Unions, the Government of India consulted the Heads of its various scientific services and non-official scientific bodies, including universities, in regard to the constitution of a National Research Council, as a result of which detailed proposals for the formation of such a Council were submitted in 1931.

The April 1940 issue of Science and Culture quoted Sir M. Visvesvaraya suggesting "applied research should be preferred as far as possible to pure research, and the research problems chosen should be distinctly industrial in character." Col. R.N. Chopra stated "Pure scientific research is as essential as that specifically devoted in the attainment of any industrial object." These arguments on pure versus applied research (they continue even today) were in relation to the necessity of the formation of a National Research Council for India.

The journal summarized the recommendations and concluded that the need of a National Research Council was widely appreciated but the proposal of Sir M. Visvesvaraya to have an unofficial committee could only be productive if the committee derived funds from the public. It was then that the Board of Scientific and Industrial Research (BSIR) was born, more or less on the lines of DSIR in England.

Thus far, 'industrial research' was a term used rather freely and repeatedly in the context of development of industries, promotion of scientific research, establishment of councils and Boards of research and laboratories to undertake research. While Prof. M.N. Saha and others of the Science and Culture group made comparisons in industrial research as obtained in the UK, the USA and Canada, the general focus of their arguments was towards having a National Council, which, left to be handled by men of Science, would integrate scientific and industrial research with the total planning of the country. The Planning Committee under Nehru

(1938) was supposed to be the forerunner. It could not function in a climate of political disturbances.

The government procedure in such situations was to set up a high-powered committee consisting of men of science, industrialists and civil servants, and expect the committee to give a report of acceptable recommendations. It was probably the view of the Government that the inclusion of industrialists would serve the needs of industrial research. The same spirit seemed to lead to the formation in 1945 of the R.K. Shanmukham Chetty Committee. In addition to eminent scientists, it had three industrialists representing the textile, the steel and the pharmaceutical industries.

The Chetty Committee also observed - 'among the Government, quasi-Government and aided institutions, those engaged in industrial research have contact with industry by having representatives of trade and industries on their advisory and governing bodies'. The method of contact, as far as universities were concerned, was of the advisory type and in some cases the institution of Industrial Research Fellowships type by which the industries paid a lump sum of money to the universities to which they referred their problems for investigations. The industrial firms in India were noted not to have developed any effective contact with the universities.

How exactly did the Committee view the prospects of industrial research in India, given the fact that (a) neither was there a large amount of industrial activity and (b) nor was there any perceptible prevalence of an industrial research culture? The Committee quoted a Report on Scientific and Industrial Research in Great Britain prepared by the London Chamber of Commerce early in 1944 .. "This country cannot afford to neglect research. Its wares must be attractive, more varied and better value for money."

There was specific mention of how research and industry had to come together, when the Committee noted - "The capacity of Indian industry to withstand international competition will depend materially on its vision and readiness to implement the latest results of research in a continual effort for improving its productive efficiency by economy in the use of raw materials, utilization of by-products, reduced power, cost and so on. Research is thus calculated to play the part of a decisive factor in India, as in the more advanced countries, not only for the maintenance of the integrity of our industries against foreign competition but also for the development of new ones for which the opportunities in this country remain imperfectly explored." Words tenable today even!

It was further noted that the research organizations had to undertake investigations with the specific object of opening up possibilities of new industries and that research could yield best results only when it was backed by a comprehensive industrial plan. And this brought the Committee up to suggesting the formation of a National Research Council, working in close cooperation with the Department of Industrial Planning.

That there was an absence of an effective liaison between the Government laboratories engaged in industrial research - some indeed specifically set up with such an object - with the concerned industries, was noted. (This criticism continued to be levelled against national laboratories of CSIR in some form or the other in the reports of the successive Reviewing Committees). It was also observed that so far as private industry was concerned, there was a manifest lack of research - mindedness among the industrialists, save for a few. Among the other important recommendations of the committee, the following merit attention:

Industry in India has no contact with research departments in universities, and as a result the latter have been handicapped for making their contribution to the promotion of the country's economy.

Many of the universities are seriously handicapped by inadequate resources. Only a few of them have workshops and necessary resources for undertaking pilot plant experiments.

(This is valid even now.)

'The distinction between different categories of research (pure, applied etc.) must not be regarded as indicative of any essential difference that would justify their organization and control on a mutually exclusive basis.' There were further recommendations on the strengthening of research in Universities.

There were dissent notes. One by Col. S.S. Sokhey (Director, Haffkine Institute, Bombay) contained this observation:

"The tendency to slavishly imitate the English practice in these matters requires to be curbed. The problems of the two countries are totally different. In spite of these obvious factors which demand careful consideration before action is taken, I regret to have to state that even while this committee was gathering information and opinion of the leading men of the country and before it could make any recommendations, plans were being made to build brand new buildings for all sorts of laboratories." Col. Sokhey stressed "efficient and progressive training is procurable only where original scientific activity is in progress" and desired that all teaching scientific departments be made beehives of original scientific research activity.

The three faces of industrial research - the research laboratory, the university and the industry - were sought to be looked at in an integrated manner by the Committee.

CSIR Reviewing Committees

The first CSIR Reviewing Committee of 1949 (when plans for establishment of national laboratories were getting ready) made the following two important recommendations -

- the greater part of the activities of the Council should be devoted to problems of research which could be directly applied towards industrial development of the country, and
- in order to make the researches of the Council of immediate practical benefit to industrialists, they should be carried as far as possible to the pilot plant stage and, for that purpose, adequate provision for pilot plants should be made in the national laboratories and elsewhere.

The second Reviewing Committee of 1954, by which time 18 CSIR laboratories came to be set up, upheld the views on pilot plants and the National Research and Development Corporation (NRDC). Research Associations were also recommended. Relationship of national laboratories and institutes with the universities was emphasized and the view was expressed that industry should be encouraged to use the facilities which the laboratories provided for solving industry's problems. Realizing the importance that fundamental research - research undertaken simply to gain further knowledge - led to new applications, the Committee felt fundamental and applied research best went hand in hand. One statement was of importance. "A certain amount of repetition and trial of existing and well known processes (or products) is necessary partly to adapt the process to conditions as occur in India and partly in training staff to become acquainted with them. It was noticed that some of the work of the institutes was of this kind."

The Mudaliar Committee of 1964 - all but three national laboratories and nine industrial research associations had appeared by now - accepted that there was in fact a need to re-orient the research programmes in the laboratories. The majority of the effort (about 80 per cent) should go towards applied research and the remainder devoted to basic objective research related to the long range objectives of industrial research. The main responsibility for pure fundamental research should rest with the universities with which CSIR had to forge close links. It was also recommended that for effective utilization of the results of research a Central Design & Engineering Unit had to be set up. The Committee became alive to the need of bridging the gap between laboratory and pilot plant researches and the stage where they were to be scaled up to industrial size units. User participation in research should be encouraged in various forms and links with industry forged in more than one way. Expert panels of scientists from industry and universities must be closely associated with programmes and control of research in laboratories. Industry should be given incentives by way of financial support to start their own research and development organizations or undertake research on approved projects with support from CSIR.

Yes, Industrial research, as it should be undertaken, was being discussed in firm tone, within the context of R&D in national laboratories.

The Abid Husain Committee (of 1986, and the latest Review of CSIR) came to the point in a forthright manner. "In the years immediately after Independence when CSIR set up national laboratories, the bulk of scientists and the scientific leadership of the organization was drawn from academic institutions. This set a tradition which is an extension of the atmosphere of a university research department. The tradition dominates the culture of CSIR even today. Scientific investigations and research have become the major activities of CSIR, while development and engineering which are technological activities related to industrial exploitation of scientific results have taken a back seat. Except for a few laboratories the interaction between CSIR and industry is not to the extent needed. The natural tendency of the system to work in isolation has been reinforced by a bibliometric reward system that puts a premium on individual excellence in science and is not conducive to team-effort where scientists come together to take up time bound projects of an applied nature." And then came the final dictum: CSIR should be required to obtain at least one-third of its total annual expenditure from outside the Central Government Core Grant by the end of the Seventh Plan (March, 1990).

What do all these add up to? We had been talking of industrial research, without actually properly defining the elements in proper perspective. Had we been talking of **research for industry** or **industrial research?** Is there or is there not distinction between research for industry and industrial research? Have the laboratories been doing research for industry? Was this misunderstood to be industrial research? In answer, let us turn to a historical analysis of industrial research in the USA.

Industrial Research in the USA

A definition of industrial research seems to be:

"In the broadest sense, industrial research involves the following four elements -

i) It is nearly organized research and as such excludes the individual inventor and the lone cut-and-dry experimenter;

ii) It employs scientific methods and scientifically trained personnel;

iii) It is concerned with the natural sciences and their related technologies to the exclusion of such areas as the social sciences; and

iv) In the long run, it is utilitarian.

The objective of R&D should be to establish a proprietary position" (William G. McLoughlin).

Further, according to Reeves, "Industrial research is a unique form of research. It is a business-oriented activity and stresses factors which do not come into play in other types of research. Industrial research is not simply the creation of new science in industrial research laboratories, but instead the mechanism through which industrial organizations respond to the challenges and opportunities of the technological environment in which they operate. The challenges and opportunities are not technological but instead are business ones."

In a paper on 'the Commercial Exploitation of Science by American Industry' Nathan Rosenberg begins with a remarkable statement - 'economists have long been content to treat science as essentially an exogenous variable, an ongoing activity in which resource allocation has not been discernibly connected to calculations of future benefits and present costs.' Going over the course of events, he points out that in terms of the number of scientists employed, chemistry has been the dominant discipline over the past century. It was the combined industrial thrust of chemistry, electricity and the internal combustion engine that generated the so-called "Second Industrial Revolution" around the turn of the century.

So we started alright; NCL was the first of the national laboratories planned. Way back in 1945, Dr. SS Bhatnagar had perhaps known this and stated - much of the work done by me is as much Physics as Chemistry and most processes are physico-chemical in nature. (He was referring to his work during the war period). Let us now have a look at what actually happened in the Organic Chemistry Division of NCL, all these years. In the first decade, the emphasis was placed on isolation and structure determination of natural products.

The next decade represented a period of high quality science with relatively less emphasis on applied work, the major thrust again being isolation and structure determination of natural products.

The decade of the seventies led to a shifting of priorities and an awareness of the necessity to utilize the research efforts to boost the economy. This further led to a shift towards applied research and greater and more fruitful interaction with industry.

In the eighties, the major areas were agrochemicals and synthesis of biologically active compounds.

The latter part of the eighties and the early nineties witnessed the growth of organic photochemistry, organo-metallic chemistry and bio-organic chemistry. But what did we do in terms of industrial research or did we not after all follow the proper route?

Prof. Rosenberg continues: "The use of the industrial research laboratory in the United States, an institutionalization of science that became particularly conscious just after the turn of the century, is closely associated with these developments." He was referring to such developments as Perkins's accidental synthesis of a brilliant mauve dye from aniline. Technological developments in metallurgy, construction, materials testing and food processing occurred in a most pronounced inter-dependent manner. In the USA, it was noted, a much larger fraction of business-supported research was conducted **WITHIN** the firm, and not by some form of industrywide association or other arrangement. **To a greater extent than appears to have been the case, say, in Britain, the growth of research in the United States was directly linked to considerations of business strategy at the level of the individual firm.**

Another important point brought out by him was some two-thirds of research and development, in recent years, has been development, and only about one-twelfth has been basic research. Economically valuable knowledge has been, to a much greater extent than is generally recognized, old not new, scientific knowledge.

It has been observed for many years that two-thirds of private industrial R&D (and that means a good 70% of total) was concentrated in five industrial sectors - aerospace, electrical and electronics, instruments, computers, chemicals and allied products. These figures reflect powerful economic (and, of course, military and strategic) determinants.

In a commentary on Rosenberg's paper, Alfred Chandler Jr. looked beyond the creation of the industrial laboratories. Agreeing with the finding that industrial research was carried out primarily within the large industrial firm, he recounts how such American enterprises as General Electric, Du Pont, and Eastman Kodak built their research laboratories. Others to follow suit were Westinghouse, Union Carbide and American Telephone and Telegraph.

"This growth in industrial research, in turn, fostered the formation of industry and nationwide research organizations."

In other words, the demand for establishment of industrial research laboratories at a national level grew from the growth in in-house R&D organizations. (Nothing of the kind has been reported in this country).

What happened in Britain, has also been analyzed. Chandler says, the British "failed, not in research, but in development. They failed because they did not create the organizational linkages. They failed to build the organization, hire the personnel and set up the facilities so central to the development of new processes and products. They failed to carry out the developmental processes that are so much more costly in manpower and money than basic research. In particular, they failed to forge the linkages between research, design, production and marketing so critical to rapid and effective development of new products." And India had Britain for her model!

Compare this with the Japanese success story. The Japanese success was one of development. Actually, two stages of use of science in industrial development stand out. The first stage is when qualified scientists and engineers are employed by the industry to work within the production system, more for testing, standardization, quality control jobs. The second stage is when they take up programmes for development of specific processes and products. According to Chandler, this resulted in a separation of the two functions and demanded "that the latter function be integrated systematically with university science and production and distribution."

Further evidence of Japan now being the technological superpower comes from Jon Sigurdson and Alun M. Anderson. It is pointed out that 'more than 10 per cent of the world's expenditure for activities in science and technology are controlled by Japanese companies and government agencies.' Due to international request that they do more basic research and share their technological research, the Japanese science and technology system may become more open and more internationalized. Yet it is in many ways the most integrated and comprehensive system which exists and may remain so during most of the present decade. The private sector in Japan accounts for more than 80 per cent of the country's expenditure on research and development. The expenditure on basic research at the universities has already been surpassed by the expense of basic research in the private companies.' After the catch-up phase of the 1970s new programmes have emerged in Japan. 'During the 1980s new species of research organizations and financing systems have been established which cut across ministerial and agency borders and increase mobility of researchers. The interface between universities and national research institutes on one hand and the industry on the other has increased.' It is also seen .... 'an extensive network of relations exists in almost all major research projects or programmes which usually involve major companies, government research institutes and universities, or university professors in their "private capacity". Such research networks .... have had a considerable impact on the establishment of joint research organizations in Europe and the U.S.' (Jon Sigurdson and Anderson).

Thus we see the integration of the industry, research and university functions in what is generally termed industrial research.

Other Points of View

There is also yet another view of the US situation, which could have been what was intended in India. In a critical analysis of the R&D situation then, Harvey Brooks wrote in 1972 - "The concentration of our R&D effort in a narrow range of sophisticated technologies for defense and space has diverted innovative talent and energy as well as venture capital away from industry and from public needs other than defense and national prestige". Time was when the US maintained a remarkable technology gap between herself and Europe, Japan. But since 1965, the position changed and the relative productivity growth of the USA declined considerably. Brooks also showed that the USA paid comparatively less attention to R&D on national objectives and basic research. The percentage share of public R&D expenditures that supported economic objectives in agriculture, manufacturing and services (1968-1969) were the lowest in the USA, as compared to Canada, the UK, France, Japan, Sweden and the Netherlands.

He was making out a case for the need for a federal role in technological innovation when the government was the ultimate user and the goods or services produced were acknowledged to be "public goods". He was also ready to prove that "the government in particular has been a source of much generic technology as well as fundamental science, which has then served as a substrate for technological innovation by the private industrial sector." He quoted the examples of the formation of several government agencies which influenced the priorities of entrepreneurs and innovators in the private sector. (Did our planners believe this would happen in our country?) The military was also a direct or indirect source of technological innovation. Investigating the rise of trend in R&D expenditure, he noted that since 1975 there was a steep rise in the share of expenditure by private industry. While the period 1945-65 was the cold war period, the second one between 1965 and 1978 was the social priorities period; thereafter it was termed the industrial competitiveness period. It was, however, true that the percentage of federal funding of R&D on Defence continued to grow - from 12.4 in 1967 to 16.1 billions of dollars in 1986.

A general refrain of Brooks' arguments centred round his concern that the USA was losing its competitive edge in technological superiority to Japan, and possibly Europe. He advocated the entry of the government sector into civil R&D (agriculture, health, services and so on), which might lead to better technological innovations, in a far more deliberate manner.

Brooks' concern was shared by leading scientists and policy makers when they met in 1991 at MIT to discuss the question - The Technology Race, can the US win? The questions posed were -

What are the appropriate private and public roles in technology research and development?

Should the US always expect to be the technological leader?

How can, and should research universities contribute to the transfer of new technologies to private industry? and How does a technology policy differ from a science policy and should the US have one?

Robert White felt that the 'principal responsibility for maintaining and advancing competitive US commercial technology base lies with private industry'. He listed those technologies in which the US was weak, was losing badly or had lost, and examined import penetration of certain US high-tech products. It was revealed that the US industry as a whole spent in 1988 a total $6.2 billion of corporate funds on foreign R&D (10.5 per cent of their domestic R&D spending). Some analysts put the figure of 1989 at 13 per cent. This was evidence of the globalization of activities by the multinationals. The question was 'how can we

(USA) best capitalize on these trends or shape them to increase our effectiveness as a nation?' One of the conclusions drawn by him was - 'we need to improve technology transfer mechanisms from universities and government laboratories to industry.'
This conclusion has to be viewed in the context of the finding that in most cases, the industrial contractor was guaranteed a profit as a result of his research effort and the government assumed the risk of cost over-runs. In addition, the knowledge and experience gained during the R&D process guaranteed the performing firm a competitive edge. Thus the costs of technical innovations in the entire field of electronics (military and civilian) were in a large measure borne by the US government organizations (Defence Department, NASA) and thus shifted to taxpayers.

There is evidence of the slow globalization of Japanese science and technology. The change may be seen in the globalization of Japanese company research. Japanese companies like Sony and Canon only have 2 per cent of their R&D activities outside Japan. Compare this with Philips in Holland and Ciba-Geigy in Switzerland which have roughly one half of their R&D outside their home countries. However, Siemens in Germany has 15 per cent of its R&D outside Germany and IBM has around 40 per cent outside the U.S. Many of the major export-oriented companies in Japan have indicated that they will by 1995, have major R&D activities outside Japan." NEC and Sumimoto Electric indicate that 10 per cent of their R&D activities will be outside Japan in 1995 and Hitachi has forecast that one third of all its researches may be outside the country by the end of the century.' (Jon Sigurdson and Anderson).

Recent trends in US government - spending on R&D have come in for questioning by the National Science Board, the policy arm of the (US) National Science Foundation, which released a report on the competitive strength of US industrial science and technology. The Board put out data to show that government spending on industrial R&D was on the decline and recommended that "the government re-orient its R&D budgets away from defence missions and towards the needs of industry". The idea was such investments as percentage of GDP, should match Japan, the world leader in industrial R&D spending. There was a suggestion that government make permanent a now-temporary R&D tax credit and remove that portion of the tax code that encourages US companies move their R&D to foreign countries to get the benefit of a tax rebate on overseas sales. This did not mean that the U.S. firms spent any less on R&D.

Many companies, as per data available with Schonfeld Associates, continued to spend in the USA at a rate faster than inflation.

CSIR Experience

Back home, in a perceptive analysis of the technology transfer mechanisms existing in India since Independence, Bhojwani concludes 'the impressive industrialization has been due, and often despite, the contributions of the several actors, on the scene, technology being but one of the minor players.' The mechanisms identified were - international grants/loans, inter-company collaborations, technology transfer agencies, indigenous technology development sources (R&D institutions etc.) and consultancy agencies. One of the confirmations that came up as a result of the IV RBI Survey was foreign collaboration agreements were rather poor instruments for raising imports; on the contrary they could be vehicles for introduction of imports.

It is now pertinent to address ourselves the question - how have the CSIR laboratories fared in terms of technology transfer? In other words, how well did they perform or not perform industrial research? Some specific examples, in the case of the laboratories under discussion, can be cited.

The first case is the establishment in the early seventies of the Central Electronics Ltd. (CEL), as a public sector company under the Department of Science and Technology. This grew out of the pioneering work of the Radio Components Unit under T.V. Ramamurthi. It was turned, quite some time after the submission of the Blackett Report on NPL, a development-cum-production unit for ferrites and after a lot of inter-ministerial considerations, took shape in the present form. It remains, as has been pointed out earlier, the only public sector company to have come out of the R&D efforts of a national laboratory of CSIR. It is also a unique case of research in a laboratory generating demand for commercialization and forcing the laboratory to turn an entrepreneur.

The NCL development of Encilite-1, a zeolite catalyst for xylene isomerisation and the subsequent development of the process of xylene isomerisation by the Indian Petro-Chemicals Corporation Ltd. (IPCL), Vadodara in association with NCL and the Engineers India Ltd. (EIL), is another instance of successful transfer of technology.

The decision to go in for catalysts was taken by NCL in early 1980. Sustained efforts led to the development of Encilite, which seemed to meet world standards. Was this enough? No; in the total innovation chain, the other steps needed were scale-up of production of the catalyst, pilot plant simulation, testing the life of the catalyst, complete simulation of the xylene isomerisation process and finally the risky job of plant trial. Naturally, these were beyond the scope of a laboratory like NCL.

However, IPCL came forward. A research programme was worked out between the public sector company (IPCL) and a national laboratory (NCL). Industrial research, in all its connotation, was beginning to take shape. Results were promising and the possibility of commercialization was indicated. It was then time to bring in an experienced zeolite manufacturer. Associated Cement Co. (ACC), the only organization in the country with facilities for large-scale manufacturing of zeolites, was the obvious choice. The company understood the task to be not a mere import substitution but the production of a brand new product, a deliberate attempt to leap frog. After repeated tests and analyses of volumes of data, the conclusion reached was - encilite catalyst was comparable to any other similar type available elsewhere in the world.

Risk analysis by IPCL indicated a possible loss of Rs.80 lakh if the proposed commercial run was undertaken. The company decided to stick its neck out.

In June 1985, the commercial test run commenced. The results far exceeded expectations. The actual loss was less than a fifth of what was calculated. On the cards was a catalyst with advantages of high throughput, excellent stability and low energy consumption. A thoroughly indigenous xylofining process (in some ways better than imported processes) had been established. IPCL in association with NCL and EIL is now offering a technology package for xylene isomerisation including catalyst not only to Indian units but to foreign firms also, against stiff competition from the best companies in the field the world over.

The firm roots of CLRI in the Indian Leather Industry and the almost symbiotic growth of the two had already been examined in detail in the previous chapter. The generation of demand for improved products and processes within the industry was an important part of the activities of the research laboratory. The scientists and technologists of the Institute, led by Nayudamma, had their feet literally well planted in the tan-pits of the industry and provided advice and technical knowledge as and when necessary. This was industrial research at its best, brought about by several factors, chief of them being the very state of the industry when the laboratory came to be set up.

OECD claims to have pioneered studies relating to high, medium and low R&D intensity products. Industries are grouped according to the share of R&D expenditures in the value of output. This approach has since been introduced in a series of studies on technology-related aspects of international trade. Among the high R&D intensity manufactures are: aerospace, computers, electronics, drugs etc. Medium R&D intensity manufactures are: automobiles, chemicals, rubber and plastics, non-ferrous metals, etc. Low R&D intensity manufactures are: stone, clay and glass, tobacco, ferrous metals, petrol refining, paper and printing and footwear and leather.

The Director of CLRI, Dr. Thyagarajan says,

"May be, but we have had a comparative advantage in the leather sector. The industry has done well over the years and if it has to maintain its position as a major foreign-exchange earner, it has got to modernize itself and go in for far more sophisticated technology. That is where CLRI comes in. I think we should have different criteria to judge the R&D intensity of this commodity in our country, particularly because there is a squeeze on raw material availability. Judged from any angle" he concludes, "leather is important for India and deserves more attention."

The position was neatly summed up by one of the leading leather technologists of the country, Dr. T.S. Krishnan, a former deputy to Nayudamma. (Later, Krishnan became the Director of CLRI). "We are dealing with a perishable commodity. The raw material is different in different places; and with so much emphasis these days on quality products, the tanner has but to follow the route of continuous technological upgradation. That demands constant R&D, which again generates a higher level of technology. The cycle is unending; neither the researcher nor the industrialist can or wants to get out of the cycle."

Then there are examples relating to technologies for production of pesticides, baby food 'Amul', Swaraj tractors and titanium anodes.

There is a case of NCL which tells us how and why transfer of technology failed. Actually it was a case of failure of a successful technology. As Bhojwani and Lal put it, there were lessons to be learnt in technology management from the failure of a successful technology. It was the case study of methyl chlorosilanes for which technology was generated by NCL. Its development was ideally managed from innovation to commercial production. The technology and products were demonstrably superior. It was offered as a fully proven and guaranteed technology package. Yet, pressures and manipulations to import technology gained in intensity as the Indian technology matured.

Giving a blow-by-blow account of the successive rejections of applications for import of technology followed by appeals which revived the whole issue, the authors show how the Government vacillated time and again on the issue of standing by a commercially proven indigenous technology, particularly when it came out of one of its own industrial research laboratories.

"Appropriate protection to national industry and technology from unequal competition from abroad" say Bhojwani and Lal "has been an essential policy measure adopted by even the most industrially developed nations. The USA has practised protectionism in steel and other industries. Betraying a different aspect the state support to US industry takes the coercive shape in the form of 'super 301' and 'special 301', if the US interests in trade and patents are perceived to be hurt! Everybody does it - France, the European community and, of course, Japan. The high-technology game is not played on simplistic assumptions like, if it is good, it will sell."

The conclusions are inescapable. 'If we have learnt anything from the case of chlorosilanes, it is a clear lesson of the failure at the national level to translate pronounced policies (Technology Policy Statement being one) into practice, and to manage a high level technology to secure national advantage. It would also indicate to other countries aspiring for technological self-reliance that when there be need, proper Technology Management would demand more and not less government intervention.'

There does not appear to be any other case - either a success or failure - of transfer of results of industrial research undertaken by any of the other laboratories under discussion here.

In-house R&D

We now turn to another important area viz industrial R&D undertaken in the industries themselves.

A scheme for grant of recognition to in-house R&D units in industrial sector and private and public funded research and development laboratories was being operated by the Department of Science & Technology of the Government of India since 1973. It is now being dealt with by the Department of Scientific and Industrial Research (DSIR). One of the objects of this scheme is to provide liberalized import facilities to recognized R&D units for equipping their laboratories with equipment components and raw materials necessary to carry out R&D work in order to updating the technology and effecting improvements in the manufacturing processes, introducing new products, processes, developing substitutes for imported items, etc. Fiscal incentives for in-house R&D are many. These include 100 per cent deduction of the expenditure incurred on scientific research, investment allowance under section 32-A(2B) of the Income-tax Act and custom duty exemption on the scientific equipment and consumables imports by the non-commercial institutions.

The number of in-house R&D units recognized by DSIR increased from about 100 in 1973 to 1188 as on 31 December, 1988. Of these about 100 are in the public sector and the remaining are in private sector and joint sector. One reason for this could be ..... "the divorce of government laboratories from manufacturing and marketing" ..... placing them "at a great disadvantage in generating and selling technology which is reflected in the steady shift away from them and towards in-house R&D". (A.V. Desai)

Have these brought about the much-needed research consciousness among the industries in the country? Has the industrial research culture been developed as a result of so many incentives and policy options offered by the Government? Have we at any stage emulated the examples of the US and Japanese firms in terms of successfully applying industrial R&D results for general enhancement of productivity, profitability and competitive skills?

By way of answers, let us look at a report by K.V. Swaminathan. According to him, the Indian industry has substantially been built on technologies developed elsewhere. This is supported by the figure of over 11,000 collaborations so far entered into. Around 800 collaborations are finalized annually.

One of the difficulties in industrial R&D penetrating here arises from the fact that many of these units are capital intensive and technological upgradation in them would involve use of fresh capital goods. This means yet higher costs of production.

Swaminathan has a suggestion here. "Formulation of possible joint R&D programmes involving two or three groups would be beneficial. The opportunity for testing an innovation developed in a university or working out some details in a research laboratory at a pilot plant level in an in-house R&D unit will provide a logical sequence of carrying the invention to a stage of commercial utility. Such interaction among the university and research institutions and R&D

centres of industry should be encouraged and constraints and obstacles identified thereon should be removed."

Once again the inevitable three faces of development - the university, the research laboratory and the industrial unit - show up for recognition.

Should there be tax incentives provided by the Government for R&D in Industry, was a question that exercised the policy analysts of the USA quite some time back. Edwin Mansfield made an analysis of the basis of the incentives as obtained in the USA, Sweden and Canada. But the commentary by Lewis Branscomb on Mansfield's analysis reveals interesting facts of the problem.

According to Branscomb, in deciding what R&D activities the federal government should undertake, the following principles should apply:

- Government should support scientific and engineering research in universities that provide the knowledge base and the graduate training on which the private sector depends.
- **Government should also assure the health of both the environment and the process for innovation and not substitute itself for the more effective private sector process of technology generation.** Government officials are too far removed from the short-term vagaries of the marketplace to be sufficiently sensitive to these subtle and often decisive influences. The time constant for change in direction in government - directed work is much too long.
- Any proposal for federal funding for R&D aimed at benefits to employment and economic competitiveness should be subjected to the following tests: Are detailed first-hand knowledge of competitive market conditions and requirements for production and service costs necessary to make the R&D useful and competitive?

  If so, government should restrain its zeal to help in this manner.
- When the government agencies, which do not have the knowledge of the market and do not have knowledge of the economics of R&D, try to target commercial technologies of importance to the economy, they end up wasting their money; they end up distorting the competitive private marketplace and

government policy officials are driven to find a tool that does not have these deficiencies."

These may sound extreme views but there appear to be points that need very careful consideration. Which is what CSIR is doing today.

New Dimensions

We started this investigation by going into the factors responsible for the establishment of national laboratories which by their R&D work, would serve the cause of industrial development of the country. The historical analysis pointed to their getting established for factors that may not qualify for industrial R&D in the present day context. This is definitely so if we compare them to the USA (and by its comparison to Japan) where industrial research has been known to have been a success.

Do we conclude, on the basis of the historical evidence and analyses made by several scholars, that there is after all a difference between what we understood to be industrial research (within the ambit of the programmes of these national laboratories) and industrial research per se. 'There certainly seems to be a difference between research for industry and industrial research' was the opinion of the NCL Director, Dr. RA Mashelkar. 'It will be better if we undertake more of industrial research, and that is what we propose to do at NCL' he observes.

Dr. AV Rama Rao recounted how he was deliberately driven to, and, probably stumbled on, industrial R&D.

Rama Rao, one of today's top ten organic chemists in India, is out-and-out a CSIR product, having started his career as a Research Fellow and reaching the top rung of the ladder to become the Director of a national laboratory (the Indian Institute of Chemical Technology (IICT), Hyderabad). In his 1991 Vishwakarma Medal Lecture entitled "Sidelights on Synthetic Drugs", Rama Rao says he succeeded in doing industrial research "due to various circumstances that forced me to initiate developmental work for reasons of survival and to remain in research." "In one of the meetings in 1972 he (Dr. B.D. Tilak, the then NCL Director) directly pointed out to me stating that my research activity with Prof. Venkataraman (Rao's guide) would not help me if I were to survive in NCL unless I initiated some programmes on industrial research." Rama Rao had been given the impression that "basic research calls for intellectual exercise and industrial research is a mediocre exercise. In fact the barriers were created by our academicians who have no knowledge about industrial research". Which was what Rustom Roy is reported to have said of scientists in the USA. "US Science and Technology policy advisers are idiots who have never seen factories." Explosive though Roy's statement is, the truth dawned on Rama Rao, who is now one of the successful scientists of CSIR as far as industrial research is concerned. He asserts, "I strongly believe that any project initiated in a CSIR laboratory will not be successful unless there is a commitment and close collaboration from the industry personnel for technology development and the subsequent transfer to production."

This was in effect a restatement of the observations of Nathan Rosenberg in his book 'The Black Box'. Citing the experience of Shockley, Rosenberg observes - 'Clearly, the main flow of scientific knowledge during this period was from industry to the university.' 'Thus even when some basic research does precede a technological breakthrough, it is the establishment of a tangible link between technology and the specific field of science that is responsible for the great intensification of research in that field.' It was almost the same case with nuclear physics after the achievement of fission in 1938 and the consequent developments during the Second World War.

As far as application of science for industrial development is concerned, one of the conclusions reached by Rosenberg is extremely valid in the Indian context. He says - 'It is fair to assume that decisions on the pursuit of science are subjected, in these profit-making firms, to calculus of private costs and benefits.'

In a conference organized in February 1992, the Directors of national laboratories discussed the Strategy Perspectives of CSIR.. A SWOT analysis was made and it was noted that CSIR is in a position to develop internationally competitive technologies in selected areas. Its track record has been satisfactory. It has been calculated that since inception the Government had invested about Rs.2500 crore in CSIR whereas the cumulative industrial production based on CSIR know-how is more than Rs.10,000 crore.

The change in industrial policy has been perceived to result in diminishing government grants, imposing pressure on CSIR to generate funds for itself, enabling CSIR to have more freedom in the choice of its programmes and clientele and drying of sources of funds from other government departments and public sector enterprises.

A threat perceived was that with minimal control on import of technologies, the private sector may not look up to the national laboratories for newer and more competitive technologies. The assumption here is that the private sector will earn enough foreign exchange by its exports to enable it to pay for further import of competitive technologies from abroad.

That global competitiveness is the concern currently in the US is evident from several analytical papers on the subject of Research Management. Graham R. Mitchell points out that the scope of industrial research in the US and the role of research managers has expanded significantly during the last two decades. "The research management agenda has evolved and broadened from the 1970s' concern with managing the research function to today's challenges of global competitiveness." For those engaged in R&D, credibility with the business community within the corporation and beyond will continue to be critical.

Government Funding of R&D: Overview

There has been a general world-wide review of the manner and extent to which governments could and should support industrial research. This came to be noticed collectively for the first time at a meeting of heads of scientific agencies in Australia a few years ago. Governments had made it clear that the national laboratories, hitherto funded wholly (or very nearly entirely) by governments, had to go out, sell their R&D results and earn a sizeable portion of their expenditure. The percentages of earnings stipulated varied but the message was loud and clear. So it was that CSIR had to earn a third of its earnings before the end of the Seventh Plan (1985-90). As the managements of the scientific agencies were gearing themselves up to winding their way towards goals set, further changes in the global situation loomed large enough to force them to hasten their steps. Global competitiveness had become the buzzword and research agencies world over had to place themselves in different perspectives and try different forms of management models in the context of globalization and privatization of R&D. Recently, CSIR seized the opportunity of exchange of ideas on the subject with those agencies with which it had entered into bilateral cooperation agreements. As a part of the Golden Jubilee Celebrations, CSIR organized in September 1992 an International Conference of Heads of Scientific Agencies (ICOHOSA'92, New Delhi) which was attended by, among others, the heads of scientific agencies of Germany, New Zealand, China, Norway and Sweden. Their views, presented during the conference, reflected the general direction in which industrial research was being driven in their countries.

In Germany, in real terms, R&D expenditure increased annually by about 4 per cent. Of the total R&D expenditure, 65% was funded by the industry. Industry (accounting for 70 per cent of the total R&D) concentrates predominantly on development in the ratio of development to research being 10:1. In the field of industrial research, a significant role is being played by technology transfer bureaus which organize cooperation between universities, research institutes and industry. Technology centres as sites for the establishment of innovative companies are growing up around technical universities. This stems from their belief that successful application-oriented (basic) research requires interlinkage and transfer between research and development i.e. between the universities, non-university research and industry.

New Zealand, it was reported, had just then concluded a radical restructuring of its publicly funded science. The changes had taken place in an environment in which there would be minimum Government intervention in the market place and included, among others, the dis-establishment of all publicly funded science providing Ministries or Departments (including DSIR) and the creation of 10 autonomous Government-owned companies established as research companies under the New Zealand Companies Act (Crown Research Institutes).

The Chinese model emphasized the need for the government to fund R&D directly, particularly the basic and the strategic kind. It did, however, recognize the importance of the need for industry to finance R&D activities so as to achieve better interaction between S&T and economy. The key element of the management model of the Chinese Academy of Sciences (CAS) was "One academy, two operational mechanisms".

In Norway, in the past, the tradition was to have strong links between the Government and the research institutes. The emphasis now is to forge links between the industrial companies and the research institutes.

Sweden's case is very revealing. The country allocates about 3% of her GNP to R&D. About 65% of R&D is carried out within industry and the larger part is spent on development of products, processes and systems.

In Britain, the question now being asked is - Rothschild revisited? The Advisory Council on Science and Technology (ACOST) has now suggested ..... "that the Rothschild principle" of customer-contractor research "be developed into a new purchaser-provider basis for all mission-oriented research. In particular, this would mean formally separating funding agencies (such as the research councils) from institutions carrying out research." NATURE feels that there will be two different approaches for long-term and short-term research. ....."a range of research-related activities would be made more vulnerable to short-term political and economic pressures." More over, "until British industry demonstrates a commitment to the long-term view in its own research spending, the argument that its approach to the organization and funding of science can be safely expanded into a national strategy should be regarded sceptically." (Rothschild Revisited).

The shift from "protectionism" to open competition in the market place is thus very clear.

CSIR's Future

Although the role of CSIR laboratories is expected to be to develop globally competitive and nationally relevant technologies, can they do so in the existing set-up? It is generally conceded that as far as the competitive edge of technology is concerned CSIR is yet to make a mark in international markets (one or two exceptions - zeolite catalysts, drug development - are there, indeed). The weaknesses in the system - lack of adequate design and engineering capability, inadequate user linkages, no definite commitment by the user, and of course, lack of knowledge of economics of R&D and the market - are too well known. Industrial research activity, wherever it has succeeded, has kept aloft the commercial interest and in a situation where the government (and not commercial interests as represented by firms) is the main source of funds, commercial interest is seen to suffer. It is now recognized that "a first rate technology" cannot be marketed by "second rate marketing personnel" whereas the converse may be true.

This year (1992) CSIR completes fifty years of its existence. At its half-century mark, it has a proud record of achievements and also has received repeated knocks on its head, by the various Reviewing Committees. It has established 40 national laboratories, the last one having come up in 1981 (IMT, Chandigarh). Some qualify to be called "the industrial R&D laboratories".

What kind of a role does one recommend to the industrial research laboratories of the country, particularly to those of CSIR? There were some ideas provided recently by Dr. Arcot Ramachandran (Executive Director, UN Centre for Human Settlements, Nairobi and former Director General, CSIR). Laying a strong emphasis on the need for R&D in India to become globally competitive, he says "an innovator in the laboratory tends to think that his job ends with the development of an idea or, at best, with the demonstration of a laboratory model. He expects the technology of production to be developed by someone from industry. This comes out of a perception of the laboratory and the industry as two isolated, mutually-exclusive entities. They are, in fact, two components of a production chain which need to work together from conception to completion in order to produce, assess and improve. For best results, they must work together .... The research-industry get-togethers with which we are so familiar should be transformed into research-industry work-togethers - with the laboratories working as think-tanks for the industry and the industry turning laboratory innovations into industrial products. **In fact some serious considerations should also be given to locating R&D activities directly within industries and within consortia of industry and to provide fiscal incentives for such activities as well as for investment in new technologies by industry itself.** The latter, of course, is something only governments can provide, as has been facilitated by countries like Japan and Germany."

Ramachandran adds "such a felicitous relationship between government, research and industry will also help to remove the unfortunate tendency among some in the field of science and technology to consider that technology and product development are inferior to scientific innovation.: (cf. Rama Rao's remarks). Dr. Ramachandran feels that 'innovation on the shop floor is vital for the successful development of any industrial product and this, in turn, will lead to real industrial and economic advancement. The success stories of the newly industrialized countries, not far from our shores, are shining examples for us to see and learn from. We shall also learn that for success to be achieved, we will need much improved scientific and technical education and a new class of highly-qualified technicians.' Again, the trimurti of research-industry-university systems.

CSIR has made its intention clear of not setting up any more laboratories in the near future. It wants to consolidate and find out where it can improve further. In fact, in order to maintain its present level of operations, CSIR would need to "forge new alliances such as with MNCs, international organizations, etc." This, on the face of it, is a volte face, because uptill now CSIR was the only organization known to be thoroughly devoted to indigenous technology development, having fought fiercely against the import of foreign know-how and withstood the pressures of MNCs, TNCs and international agencies with vested interests. It would indeed be a turning point in its history, if just after it is fifty years old, CSIR chooses to sacrifice the fundamental principle of its existence on the altar of economic expediency, on the as-yet unproven plea that 'it is a case of its very survival'. If it were to happen, it should be allowed to do so only after the decision makers and policy analysts who influence decision making go back in history and undertake a critical analysis of the factors of establishment of these laboratories and compare them with those of other countries.

As Michael Eckert and Helmut Schubert point out, "what seems evident in today's scientific actualities (e.g. the military impact in cases like SDI or nuclear affairs) is the result of a historical process, where national characteristics, international ramifications, institutional and personal features as well as other social and intellectual factors are entangled into a pattern of many facets. In view of its enormous complexity, any attempt to describe it by way of simple lessons is doomed to failure. Nevertheless, it is possible to portray some of these facets and get pertinent impressions."

Further, 'History of any kind, be it political, social, economic or industrial, casts a long and often distorted shadow'. 'Not only is its impact on modern attitudes and behaviour frequently underrated, but it tends to be misunderstood, and its lessons misapplied.' That these things should not happen, at least as far as CSIR is concerned, is one of the objectives of this thesis.

Factors influencing establishment of an industrial research laboratory (as per analysis of factors of establishment of a few selected CSIR laboratories)

Internal

- A general process of industrialization in the wake of Independence leading to formation of R&D support centres.
- A core group functioning already under a dynamic Director of Scientific and Industrial Research.
- A special, high-powered Committee set up by the Government recommends the establishment of national laboratories for Physics, Chemistry, Metallurgy, Leather etc.
- Scientific compulsions (advancement of the discipline, warranting founding of a specialized institution).
- Assessment of needs directing decisions to formation of laboratories (usually experts, heads of scientific agencies, departments meet and decide).
- Part of a total Plan of the country (becomes a part on the basis of decision taken by groups mentioned above) for economic development. (Regional development or development of a backward region).
- Large size of a laboratory with several specializations not necessarily inter-dependent.

External

- Strong political support - first from the founder of a major industrial research organisation (CSIR) and later from the Prime Minister of the country who became the President of the research organization.
- General support from the scientific community.
- Recommendations of a foreign scientist specially commissioned to visit Indian institutions and offer comments. (He wanted the replication of the British model).
- Champions fighting for the cause of establishment of labs. (NPL, NCL - Nehru/ Bhatnagar/Saha; CLRI - BM Das; CCMB - PM - Bhargava).
- Review Committee Recommendations.
- Political pressure exerted by the Chief Ministers of States (M.P., Kerala).
- Industrial compulsions (Tower Testing).
- Strategic reasons (applicable to atomic energy, space and defence laboratories and geophysical and oceanographic research laboratories).

Possible Norms for establishment of an R&D laboratory (similar to a CSIR laboratory)

1. An objective appraisal of the economic condition of the country. This should include - availability of raw material, natural endowments such as land and capital. Labour - (skilled and unskilled) is another factor.
2. The exact nature of the industry that exists or can be developed, has to be evaluated. For this purpose, availability of land, labour and capital plus water, power, transportation etc. has to be established.
3. The crucial factor of Technology deserves special consideration. It has to be ascertained if the technology used is ancient/medieval or modern. A review of existing state be made.
4. The need for: upgradation of technology (traditional/ existing/modern) or new technology has to be established on the basis of analysis of the nature and utilization of the products coming out of the industry - are they for domestic consumption or for export etc. If for export, the competitive nature of the markets and hence the need for quality products to be obtained through continuous R&D, to be identified.
5. The need for higher levels of technology has to be understood in the context of the probable way the products of the industry are to be consumed. Lacunae in existing set up have to be identified. If R&D is not adequate, it may be examined.
6. Technology upgradation or new technologies for higher levels of productivity (labour-intensive or capital intensive; more power or less power consuming; environmentally friendly; strategic; addition to resources; value addition; socially beneficial etc.) will lead to the question of application of scientific techniques (existing or to be discovered, whether internally or from abroad) and to R&D as an important activity. (How can the new set-up overcome existing shortcomings?)
7. Questions regarding availability of sufficient number of qualified scientists and engineers in various fields have to be answered. If necessary concomitant training facilities will have

to be created. Availability of machinery/equipment has to be ensured (if they are to be imported, foreign exchange requirements have to be worked out).

8. The above factors/norms will have to be investigated and decisions regarding establishment of an R&D laboratory will have to be formed by a technical committee consisting of acknowledged specialists in the field, after ascertaining how the establishment of the proposed lab. would help the country. The presence of representatives of government departments/universities/ other institutions and concerned industries ensures - governmental support by way of resources, academic and expert opinion, coordination and avoidance of duplication and participation and/or involvement with a possible commitment that results of R&D emanating from the laboratory to be established would be utilized.

9. Factors that have to be considered re: location of the Institute.

10. Political support - (generally for Science) - by way of a declared policy that indigenous R&D efforts will be encouraged. For strategic reasons, political support will be forthcoming for creation of atomic energy, space, defence, geophysical, oceanographic, and aeronautical research labs. In a free market economy, civil R&D laboratories, dependent for their survival on government funding alone, will find it hard to be effective.

11. A research culture evidenced by multi - disciplinary activities in the realm of Science - e.g. higher institutions, universities, research journals periodic scientific seminars/symposia and a reasonably large reservoir of S&T personnel.

APPENDIX-III

CSIR LABORATORIES AND SOME FACTORS OF ESTABLISHMENT

No.	Lab.	Year of Estt.	Broad Objectives	Some Factors of Establishment: Internal	Some Factors of Establishment: External (location included)
0	1	2	3	4	5
1.	CBRI	1951	S&T back up to the problems of building and construction industries.	Part of the plan of BSIR for establishment of eleven National Labs.	In addition to interest shown by Bhatnagar, presence of engg. institutions in Roorkee.
2.	CDRI	1951	Development of drugs, immunizing agents etc. Basic biomedical research.	(As above)	Dr. B. Mukerji piloted the project. U.P. Govt. offered the building.
3.	CECRI	1953	Basic sciences and development of indigenous technology in electrochemistry.	(As above)	Dr. Alagappa Chettiar offered land at Karaikudi.
4.	CEERI	1953	Electronics Systems for industrial and transportation applications; semiconductor devices (micro-electronics and hybrid micro-circuits) and microwave tubes required for Defence, Space and Communications.	(As above)	A total of 141 acres of land in Pilani was allotted to CEERI (Donation by GD Birla).
5.	CFTRI	1950	Stimulate the growth and productivity of India's food industry through the most efficient utilization of the nation's food resources.	(As above)	A palace and land (50 acres) were placed at the disposal of CSIR by the then Mysore Govt.

0	1	2	3
6.	CFRI	1950	Research, fundamental and applied on India's fuel resources, especially coal and lignite.
7.	CGCRI	1950	Scientific and industrial/ applied research of national importance in the field of glass, ceramics, refractories, various enamels and composites.
8.	CIMAP	1959	R&D related to introduction, cultivation, production, processing, utilization and marketing of medicinal and aromatic plants.
9.	CLRI	1953	R&D on leather, leather auxiliaries etc. Fundamental research on hides and skins, collagen etc. Transfer of technology to industry.
10.	CMERI	1958	Development of machinery, equipment, subsystems which can be commercialized for use in agriculture, industrial, transportation, food-processing sectors.

4	5
Part of the Plan of BSIR for establishment of eleven National Labs.	Nucleus functioned in the Indian School of Mines, Dhanbad. (Raja of Jharia had offered 100 acres of land).
Original Plan (As above)	Crusade in support of the Institute by Science & Culture (1941). Choice of Calcutta by BSIR. Dr. B.C. Roy was happy to see Calcutta Corporation provided land.
CSIR approved the setting up of CIMPO in 1957.	Started in CSIR; later shifted to Lucknow within NBRI campus.
Original Plan of BSIR.	Prof. B.M. Das, Chairman of Leather Research Cte. piloted. Supported by Sir A.L. Mudaliar, VC, Univ. of Madras. Land given by State Govt. Infrastructure already available. Research-Industry-University link-up strengthened. Madras main exporter of raw material then.
GB, CSIR approved of a Plan in October 1958.	Dr. B.C. Roy was the Chairman of the Planning Committee. Durgapur was chosen the location.

0	1	2	3
11.	CMRS	1956	Basic and applied research in the field of mining and allied industries.
12.	CRRI	1952	Research on highway engineering in all its aspects including road traffic engineering, transportation planning and road safety.
13.	CSMCRI	1954	R&D on Salt, marine and other allied inorganic chemicals. Desalination of brackish and sea water.
14.	CSIO	1959	Research, design and development of scientific instruments.
15.	CCMB	1981	Research in frontier and multi-disciplinary areas of modern biology - aiding development of biochemical and biological technology - providing training in advanced areas of modern biology - disseminate information, etc.
16.	CSIR CFB	1966	Production of biochemicals.

4	5
Early Plan in 1948. Prepared by D/CFRI.	CSIR and Coal Board met and Agreed to have MRS. It was to be away from CFRI and near the DG Mines Safety.
Original Plan of BSIR.	The then British Consulting Engineer (Roads) War Transport Department had a say in selecting Delhi as the location.
Salt Research Committee recommended. A research station and a model salt farm were functioning in Bombay.	Govt. of Saurashtra made an offer of a building if the Institute was located in Saurashtra.
A scheme of Planning Commission to develop scientific instruments industry in India.	The keen interest evinced by the then CM of Punjab Pratap Singh Kairon resulted in having land in Chandigarh. Availability of Swiss Collaboration for training, was another factor.
Basic infrastructure already available in RRL(H). Needed a separate identity and autonomous state. The leader was the champion. CSIR's intention to foster excellence.	Purely scientific reasons - need for a modern biological laboratory.
Est. as a grant-in-aid unit and linked to IICB, Calcutta.	In view of expansion of activities raised to the level of a national lab. (Experts' views).

0	1	2	3
17.	IICB	Taken over in 1956	Research in basic biological sciences for seeking solution of medical problems yet unsolved.
18.	IIP	1959	R&D on processing and utilization of petroleum and its products, natural gas and petrochemicals.
19.	INSDOC	1952	Wide range of documentation and information services.
20.	ITRC	1965	Occupational health; safety evaluation of industrial and environmental chemicals; diagnostic tests for environmental pollutants, etc.
21.	IMT	1984	Research in the frontier areas of microbial technology and genetic engineering.
22.	NAL	1959	R&D in aerospace engineering.
23.	NBRI	1953	Best possible utilization of the non-traditional, under-utilized economic plants.

4	5
Oldest lab. of CSIR. First non-official medical research Instt. Deserved recognition.	Prime Minister Nehru was interested in CSIR taking it over, which it did in 1956.
Started functioning in 1960 in New Delhi. Moved over to Dehra Dun during 1963-65.	An Act of Parliament in 1959. Collaboration from the French Institute of Petroleum (IFP) was forthcoming.
As per GOI orders, INSDOC started functioning at NPL. In 1963, INSDOC became an independent Institute.	UNESCO technical assistance programme; international requirements.
R&D in this area was part of the total work of CDRI. Needed to be recognized.	The group leader became the first Director.
GB approved on the basis of expert Committee's recommendations.	Efforts to set a lab. in Haryana. Finally, Chandigarh was chosen.
The lab. grew out of a scheme on Wind Tunnel by Prof. S. Dhawan and Dr. Ghatage; supported by CSIR.	There was no lab. of that kind to serve the interests of civil aviation.
Taken over by CSIR to develop it as a national laboratory.	Originally maintained as a Botanical Garden by the U.P. Government.

0	1	2	3	4	5
24.	NCL	1950	Advancement of knowledge and the application of chemical science for the good of the people.	First lab. to come up as a part of the Original Plan.	The Indian scientific community supported. Hill Report to build labs like in the U.K.
25.	NEERI	1958	Analytical techniques for precise quantification of pollutants in air, water, land and biological environment, etc. etc.	BSIR recommended: PHE Research Unit started functioning. One of the experts was requested to head the laboratory.	Arose as a result of the jaundice epidemic in 1956 in Delhi. A Conference of Public Health Engineers stressed the need for a Research Institute.
26.	NGRI	1961	Define with increasing precision the earth structure and processes on all scales - from planetary to mineral grain proportions and from its nebulous beginnings to present day.	GB recommendations.	A.P. Government provided land (150 acres) at Hyderabad.
27.	NIO	1966	Explore both living and non-living resources in the seas around India and develop technology for the exploitation of resources from the seas.	The involvement of Indian oceanographers in the international programme on Indian Ocean Expedition.	The Government of Goa offered land and facilities near Dona Paula facing Marmagoa Port.
28.	NISTADS	1980	S&T Policy studies, historical and sociological studies relating to Science and studies re: S&T and Development.	The Planning Division of CSIR Hqrs. started undertaking the studies. As they grew, the need for a separate Instt. was felt.	Started as a Centre for the Study of Science Technology and Development. The personality of the leader (a pioneer in the field) demanded recognition of the group as a separate Instt.
29.	NML	1950	R&D in various disciplines of metallurgy and allied fields.	Original Plan of BSIR.	Metallurgy was included in the areas for national laboratories.
30.	NPL	1950	Standards, Electronic and Engg. materials, Radio Physics, Cryogenics, Superconductivity, Condensed matter Physics, etc.	(As above)	The Indian Scientific Community supported.

0	1	2	3	4	5
31.	PID	1951	Collection and dissemination of information in regard to research and industrial matters.	Started as a part of CSIR Hqrs. for preparation of Wealth of India; a Dictionary of Indian Raw Materials and Economic Products and JSIR.	Expansion of activities relating to publication of journals.
32.	RRL Bhopal	1981	Development of engineering metals, alloys and composites, Building materials, etc.	CSIR's desire to be of use in different States.	Pressure from the State Government.
33.	RRL Bhub.	1964	R&D work towards conservation and proper utilization of natural resources with special emphasis on minerals, metals and energy through process and product development.	GB approved recommendations of expert committee.	State Govt. desire. (Regional Development).
34.	RRL Hyd. (now known as IICT)	Taken over in 1956	Fundamental and applied chemistry and development of knowhow and providing assistance in the establishment of chemical and allied industries.	CSIR took over the Central Laboratories of Nizam Govt. of Hyderabad.	Replication of a CSIR in the State avoided. Take over desired.
35.	RRL Jammu	Taken over in 1957	Industrial development of north-western region by identifying and solving the problems of industry by optimal resource utilization and exploration and exploitation of hitherto untapped resources of the region.	Drug Research Laboratory (Sir R.N. Chopra was Director) was taken over by CSIR.	The then CM of J&K and Col. Sir R.N. Chopra conceived of a lab. in 1940. Regional Development.
36.	RRL Jorhat	1959	To put to effective use the immense material resources of the region and develop the economy of the NE region (NER).	CSIR wanted to set up a RRL.	State Govt. desire for regional development.

0	1	2	3	4	5
37.	RRL (Tvm)	1976	Develop technologies for optimal utilization of the resources of the region.	CSIR wanted to open a Complex and took over the State Govt. Lab.	State Govt. wanted a RRL and got it.
38.	SERC Ghaziabad	1965	Application-oriented research on all aspects of structural engineering research.	Was part of SERC which was itself a part of CBRI.	SERC was moved to Madras. Due to political pressure, the Roorkee wing was retained in U.P. i.e. Ghaziabad.
39.	SERC Madras	1965	To act as a clearing house for the latest available knowledge and develop knowhow on design and construction of all types of structures.	Was part of CBRI. Activities broadened and so autonomy was considered necessary. SERC was created.	The Director's forceful personality was responsible to shift the Hqrs. from Roorkee to Madras where he built up better rapport with industries.
40.	CSIR Complex Palampur	1982	Development of natural resources of the State and provision of technological support for its industrial growth. Floriculture, Biotechnology, Hill area Tea Science, Natural Plant Products.	CSIR wanted to open up in H.P. (Originally a National Biological Research Lab. was to come up in Palampur). RRL Jammu had a small Centre here.	State govt. desire to have a national lab. Expert Committee recommended. H.P. Govt. provided land. (foundation-stone laid by VP, CSIR in 1983).

Questionnaire/Proforma/Guidelines for the establishment of an R&D Laboratory

A. GENERAL

1.0 Proposed name of the laboratory

1.1 Broad area of involvement

2.0 Location proposed

2.1 Reasons for locating the lab. there. (access, transportation, power, water, State capital, proximity to intended beneficiary, others - specity)
(Detailed justification may be appended)

3. Importance and relevance of the proposal of establishment (Part of Plan, Infrastructure Build-up, Recognition to existing group etc.)

4. Likely Beneficiaries (Target groups)
   - Industry/Economy
   - University
   - Society
   - Other R&D Laboratories
   - All Others (specify)

   (In each case, append notes)

5. A review (state-of-art) of facilities already existing in the country to undertake R&D in the area proposed and their impact (Institutions involved, evaluation of their impact, gaps noticed).

6. Indicate how the proposed lab. will overcome the lacunae/shortcomings and bridge the gaps, found to exist in the present set-up.

7. If it is for development/upgradation of skills, please specify if it will

   - help absorb foreign technologies and then develop further;
   - develop altogether new technologies;
   - work towards breakthroughs;

- build infrastructure and provide services to other sectors;
- undertake pure/fundamental research;
- help foster excellence, build competence and train people; and
- do all.

8. An outline of the competence of the group to work in the laboratory in terms of its leader, others, their achievements, etc. (Append brief biodata).

9. Has the government (State or Centre) shown interest? If so have they included the lab. in their plans?

10. Commitment/Interest/Participation indicated by -

    - Government (Land and Buildings)
    - Industry (Financial participation and commitment to utilize results of R&D).
    - University (Training facilities offered, higher degrees awarded, recognition given, teaching by R&D staff etc.)

B. <u>TECHNICAL INFORMATION</u>

1. Broad objectives; Scope and functions
   (Define the contours of areas of research, subject fields and specialization).

2. What is the proposed organizational structure

    - start as a small group/s and then expand
    - hierarchial
    - discipline-wise divisions
    - project basis
    - build groups around eminent persons

    (enclose organizational chart).

3. Phased programme of work
(specify targets proposed to be achieved during the next five years) (Give yearly; quarterly milestones).

4. Linkages already established/proposed to be established.

5. Expected Output.

6. Has an expert committee gone through the proposal? If so, their recommendations.

7. Any other relevant information not covered above.

C. INPUTS REQUIRED FOR THE LABORATORY

1. Land (Approximate area)

2. Buildings (major works to be indicated)
(List)

3. Machinery/Equipment - List of equipment costing over Rs.0.50 lakh (Foreign Exchange (FE) to be shown separately).

4. Please indicate other commitments of the laboratory in terms of major expansion programmes (with an outlay of Rs. 10 lakh and above over the next five years) and how are the commitments expected to be fulfilled. (Plan allocation, etc.)

5. Order of investments required to develop the lab. to an effective stage.

(Rs. in lakh)

No.	Heads of Expenditure	Phased financial requirements I Yr.	II Yr.	III Yr.	IV Yr.	V Yr.	Total for 5 years
1. (a)	<u>Recurring</u>						
	Salaries						
	S&T Personnel						
	Others						
	Total						
(b)	Consumables						
(c)	Travelling etc.						
	Total Recurring						
	FE, if any						
2.	<u>Capital</u>						
	Land, Bldgs.						
	Services						
	Equipment						
	Others, if any (specify)						
	Total Capital						
	FE component						
	incl: residential accommodation of staff.						
Grand Total:	1 + 2						

6. Sources of funding

Govt.

International agencies

Industry

Any other source

Total :

7. Manpower Requirements.

Scientists - Levels - Specializations

Supporting Staff - Technical

Administrative Staff -

Other Staff -

Total -

8. Any other Information, not covered above.

NATIONAL CHEMICAL LABORATORY, PUNE
Established 1950

National Chemical Laboratory (NCL) has charter for undertaking Research and Development work in specific areas such as Agrochemicals, Catalysis Science & Engg., Polymer Science & Technology, Drugs & Pharmaceuticals and Bio-technology. It gives technical back-up support to small & large sector chemical industries on process optimisation, improving plant performance, process evaluation and technology feasibility.

SIGNIFICANT ACHIEVEMENTS (1985-91)

* Encilite - 1 catalyst & technology for isomerisation of xylenes, commercialised & revamped 90,000 TPA plant at IPCL.
* Encilite - 2 catalyst for production of ethyl benzene from ethyl alcohol, commercially used by Hindustan Polymers Ltd.
* Encilium process for continuous fermentation of molasses to ethanol transfered to Dhampur Sugar Mills U.P.& Belganga Sahakari Sakhar Karkhana Ltd, Maharashtra.
* Technology for metal replacement by polymer composites in two - wheelers transferred to Bajaj Auto Ltd., Pune.
* DROP, a flow improver for crude oil & petroleum products, developed in collaboration with Lubrizol & ONGC is used in Assam & Gujarat refineries.
* Plant tissue culture technology for cardamom transferred to A.V. Thomas & Co., Cochin.
* Xylanase - LMW1, a low molecular weight enzyme for quality improvement in pulp, produced sucessesfully by Finnsugar based on NCL process for International Paper Corporation Inc., USA; commercialisation being looked into by IOWA State University, USA.
* NCL won ICMA Awards for development of technologies for Ethyl Benzene, Vitamin B6, Acrylates, Ethylene Diamine & Xylofining.

EIGHTH PLAN PROPOSALS (1992-97)

Keeping in view the objective of the laboratory, the emphasis of NCL's research and technology development programmes focus on industrial development and societal needs in the areas of Catalysis, Polymer Science, Biotechnology, Drugs & Pharmaceuticals & Agrochemicals. A few new areas such as Protein engineering, Bioorganic Chemistry will also be taken up during the 8th plan to keep in pace with the advances in science & technology the world over.

HIGH PRIORTY MAJOR PROGRAMMES:

In the area of Catalysis & reaction engineering development of catalysts & technologies for chemicals & petrochemicals such as for cumene, propionic acid, acetic anhydride, vinyl acetate monomer, catechol, hydroquinone olefins, acrolein, carbamates etc have been planned. Synthesis & characterisation of chiral zeolites/zeolites with novel structure compositions for new industrial applications would be continued. Basic studies on high pressure chemical reaction engineering, natural gas conversion & C1 chemistry are expected to result in patents and publications both in India & abroad.

In the area of Polymers, development of techniques for synthesis, characterisation and evaluation of polymeric materials are proposed to be undertaken. Processing technology for functionally grafted polyethylene cable compounds, composite Rocker Lever Brush for diesel engines, plastic wares for biological use, cost effective modified phenolic resins and R&D capability in engineering thermoplastics & high performance composites are some of the likely outputs.

Development of safer and environmentally clean & novel processes/technologies for manufacture of pesticides & agrochemicals such as carbamates (carbaryl & BPMC) through non carbon-monoxide route, Ethofenprox (MTI-500), brassinolide & homobrassinolide, propoxur, paclobutrazol and pest control agents from natural products would be taken up.

Synthesis of antihypertensive drugs, cardio-vascular drugs, family welfare drugs, anti-ulcer drugs, sedatives, drug intermediates and diagnostic kits and related process technology development work are proposed to be undertaken.

R&D work in biotechnology will focus on plant tissue culture to develop processes for producing superior plants & crops, rescue & preserve vanishing plant species & establish a tissue culture pilot plant, Microbial technology is proposed to be used for identification of novel microbial strains and exploitation of their biotechnological potential in bioactive metabolite production/enzyme technology. Plant Molecular Biology research will focus on RFLP technology in selective breeding, development of immunodiagnostic tools, genetic manipulation of seed storage proteins, development of a technology base for production of transgenic plants with genes of agronomic interest. Regulation & manipulation of gene expression of xylanases, proteinase inhibitors in plant protection, biomolecular crystallography, molecular evolution in the descent prokaryote & eurokaryote linkages, crude oil recovery & degradation are planned to be undertaken. National Collection of Industrial Micro-organisms (NCIM) programme envisages increase in strength of algal cultures to provide identification facility to taxonomists, improvement of microbial strains using various methods like protoplast fusion, mutation and hybridization.

OTHER MAJOR PROGRAMMES

R&D work in following areas constitute the other major programmes of the laboratory; separation technology including membrane materials and development of structures for separation of various process streams; development of superconducting materials under well defined conditions; development of package for characterisation of refrigerants and identification of environmentally safe refrigerants & synthetic lubricants. d) development of catalyst & technologies for petrochemical industries; development of mathematical models for chemical processes diagnosis of faults in a complex plant & software for process industries; development of new & innovative processes for synthesis of biologically active compounds and industrially important chemicals; development of processes for synthesis of high performance hard & soft ferrites from indigenous raw materials; Studies on the molecular basis of biological activity of low molecular weight enzymes and property improvement through change of structures. Bio-organic chemistry aims at basic research on DNA-drug, DNA-protein and DNA-lipid interactions drug design and delivery.

MINOR PROGRAMMES

Risk and Hazard Analysis aims at providing advisory & technical consultancy to chemical and allied industries on industrial safety.

OTHER PLAN ACTIVITIES

Recent meeting of R.C. recommended & approved restructuring of NCL. As per the recommendation of RC some research units and facilities have been identified and introduced.

These facilities need to be strengthened by way of acquiring equipment, and replacement of old and obsolete equipment so that the infrastructural facilities would be adequate to meet the time targets.

Testing and other Facilities

Instrumentation; Trouble-shooting; Chemical Industry; Design Engineering for chemical plants.

Major Programmes to face the future

Programme	End Outputs	Rationale
Catalysis	Develop catalysts and technologies in the field of zeolite catalysts for industrial processes	Industrial applications
Polymer Science & Technology	Develop new and innovative processes for synthesizing polymeric materials	To gain competence in carrying out research in frontier areas
Drugs & Pharmaceuticals	Develop new innovative and economically viable methods for the synthesis of essential basic drugs.	To cater to country's health care programme. Development of indigenous capability.

NEW PROCESSESS/ PRODUCTS AVAILABLE

SECTOR	PROCESS/PRODUCT
Catalysts	Zeolite catalysts additive
Chemicals	Ethylbenzene
Distillery	Continuous fermentation of molasses to ethanol (ENCILIUM process)
Drugs & Pharmaceuticals	Ranitidine intermediates Vitamin B6

Plant tissue culture	Plant tissue culture for Cardamom
	Plant tissue culture for Eucalyptus
	Plant tissue culture for Pomegranate
	Plant tissue culture for Sugarcane

FINANCIAL RESOURCES **(Rs. in Lakh)**

		Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1.	CSIR (X)	**1111.0**	**1095.0**	**1052.0**
2.	Extra Budgetary Resources (EBR- Income from outside)			
	a) From Private (Industry)	56.0		
	b) Public (Govt. Agencies)	244.0		
	c) Others			
	Total (2) (Y)	300.0	358.0	N.A.
	GRAND TOTAL (X+Y)	**1411.0**	**1453.0**	N.A.
	Ratio (Y/(X+Y))	**21.3%**	**24.6%**	**N.A.**

MANPOWER: as on 31/03/92

Group IV	375	Group II	237	Group V	3
Group III	122	Group I	188	Administrative	150
	----		----	Non-Tech. (Class IV)	59
Total	**497**		**425**		----
	----		----	Total	**212**

Grand Total **1134**

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):
= 252 : 258
= **1 : 1.02**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):
= 497 : (425+212)
= **1 : 1.28**

NATIONAL PHYSICAL LABORAORY (NPL), NEW DELHI
Established 1950

INTRODUCTION

The Laboratory carries out research and development activities in the areas of (i) Measurement standards and calibration (ii) Electronic and engineering materials (iii) Basic research in Superconductivity, Space Science and Condensed Matter Physics.

SIGNIFICANT ACHIEVEMENTS (1985-91)

* NPL has built up considerable expertise enabling it to shift from 'artifact' standards to quantum standards. Significant achievements are realisation of 'metre' based on stabilized frequencey laser radiations, 'farad' through a calculable capacitor linked with length standard and having 'ohm' and 'henry' traceable to it, Josephson Voltage standard at 1 mV level, interferometric monometer as primary standard of pressure, self-calibrating electrically compensated absolute radiometer facilities for magnetic flux measurements, microwave power standard, upto 26 GHz etc.

  In addition NPL undertook calibration at the highest level of accuracy for various users and paricipated in the NCTCF programme.

* Significant developments under materials development programme are: C/C composites for biomedical and space applications, PAN fibres, large area polycrystalline silicon ingots by directional solidification technique, amorphous hydrogenated silicon thin film solar cells, fluorescent screens for real time X-ray imaging, precise electro-optical colour switching and studies on materials with special reference to configurations having nonlinear characteristics, transducers for pingers of frequency 18 kHz & parametric systems for oceanographic applications alongwith techniques for characterisation of transducers in underwater condition, thin film optical coating and devices for Space and Defence. NPL has advanced facilities for characterisation of materials in all aspects alongwith a DOE-NPL Centre for characterisation of materials for electronics.

* Characterisation of the radio meteorology of Indian troposphere, Long and short term forecasting of radio propagation studies as Associate Regional Warning Centre as a part of international system of rapid exchange of solar, magnetic and ionospheric data, launching of payloads for rockets and baloons for measurement of ozone, aerosol, nitric oxide and ionization from 20 Km to 80 Km,studies on atmospheres of other planets such as venus, jupiter, saturn and uranus constitute major contributions in the area of atmospheric sciences.
* Basic studies to understand both the normal state and high Tc superconducting properties, development of wires and tapes, and development of good quality thin films and their utilisation, the development of SQUID, are major achievements in the area of super conductivity.

EIGHTH PLAN PROPOSALS (1992-97)

The 8th Five Year Plan perspectives of the laboratory may be delineated as per the following:

* To establish, maintain and improve continuously national standards of physical measurements and to realise units based on international system.
* To identifiy and conduct after due consideration, the research in the areas of physics which are most appropriate to the needs of the nation and for advancement of field.
* To assist industries, national and other agencies in their developmental task by precision measurement, calibration, development of devices and processes and other allied problems related to physics.
* To keep itself informed and study critically the status of physics in the nation and in the world.

HIGH PRIORITY MAJOR PROJECTS

Significant targets for the plan period in the area of standards Metrology are development of 3.39 um He-Ne Methane stabilized laser, interlinkage of "meter" with "second" through laser frequency measurements, National standards for aqueous flow, non- aqueous liquids flow and gas flow measurements, development of hydraulic multiplication system upto 10 MN, to set up a scale of optical radiation in the ultraviolet and visible regions, development of a laboratory model hydrogen maser and a prototype of commercially viable Rd standard, establishment of Josephson voltage standard at 1 volt level and development of 1 volt and 10 volt junction arrays, realisation of "ohm" by Quantum Hall resistance etc.

New materials proposed to be developed, besides continuing basic research are polycrystalline silicon, luminescent materials carbon fibres, laser resistant carbon composites, impregnating grade pitch, special carbon carbon composites, electrodes for high energy density battery, transluscent alumina, high output biosensors, underwater acoustic devices etc.

Targets for 8th Five Year Plan in Atmospheric Science Programme are monitoring ozone and other trace gases (bygenetic and anthropogenetic) which are critical in affecting life on earth and to develop predictive capabilities; besides participation in air sea interaction programme. SROSS-3 is a scientific satellite assigned for aeronomy studies to carry out aeronomy experiments of NPL and PRL.The targets as delineated are to fabricate the flight models of RPA and EPS payloads for SROSS-C and SROSS-3 missions respectively, to conduct simultaneous rocket experiments and to receive the data from these experiments for analysis and for understanding the ionosphere and thermosphere behaviour in low latitude.

Targets, as formulated for, high temperature super conductivity project are substitutional studies in various Tc systems, investigation on the structure - property correlation and growing single crystals of HTSCs, fabrication and study of SQUIDs devices based on high Tc superconductors and to study processes for physical limitations in achieving high critical current density.

OTHER MAJOR PROJECTS

NPL is also engaged in other major projects such as characterisation of Materials, Antarctic studies, Media characterisation, under water acoustics, VLBI etc.

Testing and other Facilities

Standardisation activities related to Parameters of length, mass, time, electrical current, temperature luminous intensity force, pressure, vacuum,luminous flux,acoustics, ultrasonics and various electrical & electronic parameters.

Major Programmes to face the future

Programme	End Outputs	Rationale
Standardisation, Metrology and Quality Systems	Meeting measurement control requirements stipulated in ISO-9000/EN-45000	This is an area where NPL is at the apex and it is imperative that continued efforts need to be made for keeping the national standards of measurement with an accuracy which is atleast one order better than what industry requires.
Newer Materials: Development and characterisation	Developing materials neded for advanced air crafts,military air crafts, missile and other Defence programmes,various advanced ceramic application, Chemical Chemistry etc.	These strategic and specialised requirements,technologies for which may not be easily available from outside.
Global Change	Atmospheric scanning-specially green house gases and their impart on ecological balance, rain pattern,sea and earth food chain and crop growth etc.	The programme for use a part of the international Geosphere Biosphere Programme.

NEW PROCESSESS/ PRODUCTS AVAILABLE

SECTOR	PROCESS/PRODUCT
Aviation	Aviation Grade Brushes
Chemicals	Distillation of Coal Tar/Pitch Coke
Electronic equipments	Liquid Crystal Display Devices
	Transducers for Pingers/ Transponders (18 kHz)
	Ultrasonic Motor
Machine tool accessories	Single Crystal Diamond synthesis using Catalyst - Solvent Process
Materials and composites	Carbon Fibres for Braiding application
	Activated Carbon Fibre/Cloth
	Water Soluble Fluxes
Semiconductor equipment	Directional solidification of Silicon Ingots for photovoltaic applications

FINANCIAL RESOURCES

(Rs. in Lakh)

	Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1. CSIR (X)	**1028.99**	**1073.62**	**1027.65**
2. Extra Budgetary Resources (EBR- Income from outside)			
a) From Private (Industry)	--	--	--
b) Public (Govt. Agencies)	261.78	207.21	322.50
c) Others	45.45	57.00	55.00
Total (2) (Y)	**307.23**	**264.21**	**377.50**
GRAND TOTAL (X+Y)	**1336.22**	**1337.83**	**1405.15**
Ratio (Y/(X+Y))	**22.3%**	**19.75%**	**26.86%**

MANPOWER: as on 31/03/92

Group IV	292	Group II	411	Group V	1
Group III	194	Group I	113	Administrative Non-Tech. (Class IV)	168 116
Total	**486**		**524**	Total	**285**

Grand Total **1295**

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):
= 486 : 524
= **1 : 1.08**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):
= 486 : (524+285)
= **1 : 1.66**

CENTRAL LEATHER RESEARCH INSTITUTE, (CLRI) MADRAS
(Established 1953)

The laboratory is devoted primarily to R&D on leather, leather auxiliaries, leather goods, leather based articles and footwear with emphasis on fundamental and applied research pertaining to hides and skins, collagen, tanning agents and tannages, polymers, finishing materials, effluent treatment and slaughter house by products. CLRI imparts training in leather technology and leather products manufacture and conducts B.Tech and M.Tech courses on leather technology and P.G Diploma and M.Tech courses in footwear technology.

SIGNIFICANT ACHIEVEMENTS (1985-91)

It is well recognised that the phenomenal growth of leather industry in the country and its export performance can be attributable to the traingular co-operation between leather industry, CLRI and Government. In quantitative terms the leather exports have registered nearly 100 fold increase since independance. CLRI's role in this has been in sensitising the leather trade to the importance of value addition and providing effective technologies and the training at the very door steps of the tannery.

CLRI has provided more efficient, environmently friendly and time saving methods for almost all steps involved in the conversion of animal skin into an export worthy value added products. Due to CLRI's effort the time involved in the vegetable tanning has been reduced to 10-15 days from 35-40 days.

In the last five years CLRI has been able to help the leather industry to modernise the tannery operations. The microprocessor based control tannery wet operations installed in a private tannery at Ranipet is comparable to that of the International standards.

With CLRI know how a number of speciality leathers like glove leather, chamis leather, mountaineering shoe leather, leather for upholestery, sports goods leather etc have been produced.

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With CLRI know how a number of speciality leathers like glove leather, chamis leather, mountaineering shoe leather, leather for upholestery, sports goods leather etc have been produced. Many of the manual techniques traditional for leather processing have now been replaced by mechanical ones.

Some of the recent significant achievements relate to devlopment of following processes/products: Seal and sink, a simple and cost effective finishing technique without the use of sophisticated machinery and chemicals; shoes upper leathers with special properties such as high degree of water resistance especially for mountaineering shoes; know-how for water repellant fatliquors based on vegetable oils; process technology for curing, tanning and finishing shark skins immediately after catch. Based on the processes demonstrated by CLRI, Harijan Cooperative Societies at Barabanki, UP are producing meat-meal on a regular basis and getting better returns from fallen carcasses.

Selected impact making technologies developed by CLRI are as follows:

* New product tehnologies for synthetic fatliquors, mineral based syntans and polymer aids for leather processing.
* Engineering packages for modernisation of wet processes activities in tanneries and introduction of computer aided design concepts in footwear sector.
* Cleaner leather processing technologies and appropriate effluent treatment technologies for tannery waste water. This has been installed in Kanpur. The saving of basic chromium salt per tonne will be equivalent to Rs.2 crores per annum.

EIGHTH PLAN PROPOSALS (1992-97)

The programmes during 8th plan have been reoriented on the basis of the needs of the leather industry. It is proposed to give thrust on modernisation of the Indian leather industry.

HIGH PRIORITY MAJOR PROGRAMMES

R&D aplications for the modernisation of the Indian leather industry: The objectives are to achieve technology upgradation, enable improvement in quality of indigenous leather products, provide adequate trained manpower to the industry, increase the preparedness of the industry to meet the challenges of post 1995 period, develop and deliver environmentally clean technologies and plan the progress of leather industry. By the end of 1997 the project alone would generate an external revenue of Rs.180 lakhs.

Design and development of footwear and leather products: Development of technologies for chemicals and component materials for footwear and leather products such as adhesives, reinforcement, stiffner materials, and shoe finishes. It is also proposed to develop apropriate process technologies for rural areas and establish well functioning leather product market research group and establish laboratory to specialise in selection and testing of footwear and leather product materials and components, forecasts of newly developed footwear and leather products.

Newer methods for treatment of effluents: The objective of the programme includes biological treatment of tannery effluents, removal of dissolved solid and evaluation of anaerobic and aerated lagoons, utilization of chrome sludge, chrome recovery and reuse and cleaner chrome tanning technology. It is also proposed to set up full scale common effluent treatment plant for cluster of tanneries in Tamilnadu with the coordination of Tamilnadu Pollution Control Board. Detailed inventory and design engineering for the proposed CET in Calcutta area and implementation of full scale demonstration chrome recovery plant in Tamilnadu.

Establishment of a model training, demonstration and R&D centre for fallen carcass utilisation through the combination of biotechnological and other techniques to benefit the weaker sections of the society (SC/ST population). The main aim is to develop viable technology for fallen carcass utilistion.

Surface and Material Science of Leather Making: Development of quntitative criteria for leather evaluation; development of new techniques and tool for characterisation of leather surface including an ultrasonic scanner; development of techniques for surface energy measurements and correlation of surface energy with functional properties of leather and leather products.

OTHER MAJOR PROGRAMMES

It is proposed to pursue R&D on development of leather chemicals; collagen structure and activity and bio-material; application of collagen; safety and risk analysis; metal peptide interactions and molecular mechanism to mineral tanning; material characterisation through micro imaging and magnetic resonance and development of novel NMR *in vivo* spectroscopy.

MINOR PROGRAMMES

Programmes proposed in bio-techniques for hide/skin preservation and tannery waste management; new enzymatic options for leather processing; molecular biology; molecular mechanism for regulation of connective tissue synthesis and stability; alternate technical options for chemical dehairing and chrome tanning; polymer synthesis and characterisation for leather applications; leathers from non-conventional sources; unusual structure and reactivities in coordination compounds;

instrumented colour matching in leather industry; bio-mechanics for footwear design; upgrading finishing techniques for inferior grade leather; mathematical modelling of tannery; super critical extraction of valuable bio-products from tannery and slaughter house waste.

Testing and other Facilities

Finished leather; Certification for export of leather/leather goods; Computer aided designing facility.

Pilot plant for Tannery - unit operations, Leather chemicals process scale-up.

Major Programmes to face the future

	Programme	End Outputs	Rationale
*	R&D application for the modernization of leather industry	Technology upgradation improvement in quality of leather and leather products	Production of high quality leather
*	Design and development of footwear and leather products	Development of shoe designs and technologies for materials required in footwear production.	Export Potential
*	Newer methods for treatment of effluents	Biological treatment of tannery effluents. Chrome recovery and chrome sludge utilization	Envrionmentally clean technologies for pollution abatement

NEW PROCESSESS/ PRODUCTS AVAILABLE

SECTOR	PROCESS/PRODUCT
Adhesives	Neoprene and PU adhesives for footwears
Chemicals	Gallic acid and Trimethoxy Benzoic acid (TMBA) from myrobalan nuts
	Polytan based on acrylic polymer
Leather (chemicals)	Keratin hydrolysate

	PU emulsion
	Cleartan CR
	Phosphorylated fatliquor
Leather (footwear)	Innovative footwear design
Leather (tanning)	Buff softie and upholstry leather
	Non-swelling pickling systems for leather
	New finishing techniques like regultaed antique effect, special shrunken effect and seal sink
	Carbon dioxide deliming
	Sheep nappa leather
	Shark skins

FINANCIAL RESOURCES **(Rs. in Lakh)**

		Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1.	CSIR (X)	**454.5**	**564.0**	**569.0**
2.	Extra Budgetary Resources (EBR- Income from outside)			
a)	From Private (Industry)	13.0	20.0	-
b)	Public (Govt. Agencies)	31.0	50.0	150.0
c)	Others *	127.0	21.0	-
	Total (2) (Y)	**171.0**	**91.0**	**150.0**
	GRAND TOTAL (X+Y)	**625.5**	**655.0**	**719.0**
	Ratio (Y/(X+Y))	**27.3%**	**13.9%**	**20.9%**

*** International agencies**

MANPOWER: as on 31/03/92

Group IV	126	Group II	147	Group V	-
Group III	126	Group I	111	Administrative	111
	----		----	Non-Tech. (Class IV)	44
Total	**252**		**258**		----
	----		----	Total	**155**

Grand Total 665

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):
= 252 : 258
= **1 : 1.02**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):
= 252 : (258+155)
= **1 : 1.64**

REGIONAL RESEARCH LABORATORY (RRL-TRI) THIRUVANANTHAPURAM
Established 1976

The laboratory was established to develop technologies for optimal utilisation of the resources of the region specifically for minerals and post harvest processing of plantation crops and to help the industries through research development and technology transfer.

SIGNIFICANT ACHIEVEMENTS (1985-91)

* A demonstration unit designed by RRL-Tri for edible palm oil was established for ICAR at Palode.
* A demonstration plant for coconut cream has been established at Coconut Development Board Cochin.
* The laboratory has been able to remove graphite from clays with the successful commissioning of commercial level flotation cell.
* A demonstration plant for making Coir Polymer (sheet moulded compound) sheets has been commissioned at CICT Bangalore.
* A pheromone for sweet potato weevil has been synthesised and field tested in collaboration of ICAR. The extract of wild pepper was found to inhibit feeding in'pollubeetle'and could be used as antifeedant.
* Developed computer models for liquid-liquid extraction/and separation of rare earths solidification of metallic systems.
* Synthesis of zeolites for detergent formulation at pilot plant scale has been completed and 250 kgs have been supplied to industry.
* Silver YBCO and silver BPSCCO composite powder containing 50% of silver have been prepared and transformed in to superconducting wires and coils.
* Photochemistry laboratory has been established for synthesis of organic substrates monomers for photo cross linking and photo reactor.
* A process for the treatment of latex centrifuge effluent has been transferred to an industry.

* Technology for effluent processing for UASB reactor system has been developed.
* Laboratory has been developed as an Applicate Authority on Species.
* 300 Research publications and 20 patents have been brought out.

EIGHTH PLAN PROPOSALS (1992-97)

During eighth plan period the laboratory would undertake R&D programmes in the following areas:-

* Processing, standarisation, quality evaluation and extraction technologies, for high value added products and dissemination of know-how on plantation products e.g. spices, oil palm coconut. Biological pest control for plantation crops has also been envisaged.
* Industrial consultancy for processing of mineral products e.g. clays. Indigenous technologies will be developed for extraction of rare earths from non-nuclear beach sands. Development of effluent treatment processes for the above will be continued.
* Synthesis of metal matrix composites, oxidic ceramics, speciality polymers .

HIGH PRIORITY MAJOR PROGRAMMES

* The laboratory has plans to design screw press and prototype unit for destearination of palm oil in collaboration with CMERI. Bio-chemical and nutritional aspects of the raw palm oil as a source of vitamin A will be investigated. Recovery of palm kernel and carotene from palm oil will also be taken up.
* Development of indigenous analytical procedures for simulation of liquid - liquid extraction circuits for separation of rare earth with a variety of extractants have been planned. Preparation of individual rare earth metals and alloy for specific applications are also proposed to be undertaken.
* Development of high temperature superconductivity materials and preparation of submicron high purity ceramic oxides and study of their sintering behaviour would be undertaken. Fine powders will also be prepared.

OTHER MAJOR PROGRAMMES

* Synthesis and field trials of pheromones and antifeedants for the pest control for major plantation crops of the region, have been proposed.
* Synthesis of the monomers, polymers and copolyesters indigenously is envisaged for development of ablative produts from CNSL.

* Isolation and strain improvement of bacillius cultures of CG Tase through fermentation technology are proposed.
* Research in understanding the various phenomena encountered in the useful applications of photo chemical processes on both fundamental and applied aspects of photochemistry is proposed to be undertaken. The activity will centre around three main areas (a) organic chemistry (b) solar energy (c) photochemistry.

MINOR PROGRAMMES

Alternate flow sheet for direct reduction of high grade synthetic rutile, value added products like zeolite, molecular sieve for clays, rare earth added aluminium alloys, quality AC alloy casting and synthesis and secondary processing of composites constitute minor programmes of the laboratory.

OTHER PLAN ACTIVITIES

The laboratory has proposed all round modernisation for which new equipments are to be acquired. Extension of building is also needed for accomodating new facilities and equipment.

Testing and other Facilities

Referral Centre for rare earths; Clays, ceramics, composites & alloys; Plantation products.

Major programmes to face the Future

	Programme	End Outputs	Rationale
*	Metal Matrix composites	Aluminium Alloy matrix composite with silicon carbide reinforcement	Indigenous development
*	Spices	Processing standardization quality evaluation and extraction of fruits flavoured oleoresins of major spices such as cardamom pepper ginger & turmeric powders	Export oriented value added products
*	Pollution abatment measures related to Industrial effluents	Process for sulphate effluents Process for Rubber Industry Process for immbolisation of tannery wastes	Cleaner Technology

* Material processing, value addition, ilmenite, rare earths and clays	- New methods of processing of ilmenite, Rutile - Liquid liquid extraction of rare earth - Process development of Zeolite	Indigenous development
* Photo Chemistry	Polymer linked photo sensitizers and degradation of pollutants	Capability building
* Oil palm processings	Scale up palm oil extraction Refining and distearination to match extraction plant	Capability building

FINANCIAL RESOURCES (Rs. in Lakh)

		Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1.	CSIR (X)	**319.0**	**385.7**	**283.7**
2.	Extra Budgetary Resources (EBR- Income from outside)			
	a) From Private (Industry)	1.5	1.7	--
	b) Public (Govt. Agencies)	24.7	74.3	80.0
	c) Others			
	Total (2) (Y)	**26.2**	**76.0**	**80.0**
	GRAND TOTAL (X+Y)	**345.2**	**461.7**	**363.7**
	Ratio (Y/(X+Y))	**7.6%**	**16.5%**	**22.0%**

MANPOWER: as on 31/03/92

Group IV	81	Group II	52	Group V	2
Group III	33	Group I	13	Administrative Non-Tech. (Class IV)	76
Total	**114**		**65**	Total	**78**

Grand Total **257**

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):
= 114 : 65
= **1 : 0.57**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):
= 114 : (65+78)
= **1 : 1.25**

REGIONAL RESEARCH LABORATORY , BHOPAL
(Established 1981)

The laboratory was set up to develop technologies for the optimal utilisation of the resources of the region (minerals & metals, forest products & water resources etc) and to help industries of the region through research and development and technology transfer.

SIGNIFICANT ACHIEVEMENTS (1985-91)

Four demonstration cum training programmes in the low cost housing were organised. HUDCO has set up a building centre at RRL Bhopal for training and demonstration of technologies for low cost housing. A process for making unglazed ceramic tiles from pyrophyllite mineral has been developed. Process for natural fibre cement corrugated sheet as replacement of cement asbestos has been developed. Process for black cotton soil clay and fly ash bricks has been demonstrated. Training programme for upgradation of metal based industry of Bastar region was organised for the benefit of tribal people.

A Process for the manufacture of aluminium graphite particle composites developed & assigned to NRDC for technology transfer.

Another process of aluminium alloy ceramic particle composites containing upto 25% silica sand have been synthesized by solidification of short ceramic fibres of - silicon carbide, Al_2O_3,Si_3N_4 and AlN have been produced successfully on laboratory scale.

EIGHTH PLAN PROPOSALS(1992-97)

The orientation of the VIII Five Year Plan programmes is given below:-

Technology development in the areas of low cost/alternate building materials, components and aluminium metal matrix composites components for aero space applications.

Development of process for beneficiation and industrial utilisation of some fertilizer minerals of Madhya Pradesh, modelling and optimisation of the beneficiation process for treating coking and non-coking coals, development of tribomaterials, Dev. of composite materials, alloy as well as

Water resources management and planning.

HIGH PRIORITY MAJOR PROGRAMMES

Commercial production of sisal cement roofing sheet, cement/polymer composites as a substitute of wood, red mud cements bricks from industrial by product and low grade soil are proposed to be undertaken.

It has been envisaged to undertake beneficiation/upgradation of low grade ores including development of indigenous resource base particularly for fertilizer minerals and tin ores etc. An economically viable process for Rock phosphate glauconite sand stone will be established.

RRL will also develop composite materials like aluminium based composites, ceramic matrix composites, cast composites etc. for various engineering applications.

Beneficiation studies on coking and non-coking coals including coal preparation, control strategy, process optimization, Entrainment studies on froth flotation and mathematical modelling for different unit operations will be taken up. An industrial Vorsyl Seperator unit will be installed at West Bokaro Washery.

OTHER MAJOR PROGRAMMES

Aluminium based alloys e.g. zinc-aluminium alloy, Nd-Fe-B having optimized composition and microstructure properties will be developed to achieve best performance of alloys.

Development of Tribomaterials and microstructures for mine implements will be taken up. To obtain best wear performance, composition and structures of ZA alloys and its composites will be optimised.

Remanant Life Prediction of Engineering Materials have been envisaged to monitor the conditions of thermal power plant equipment subjected to high temperature and high pressures.

Studies on water resources management and planning through computer modelling in different basins of Madhya Pradesh including water quality studies and estimation of ground water and surface water resource potentials would be undertaken.

OTHER PLAN ACTIVITIES

This is a relatively new laboratory. The infrastructure is proposed to be strengthened to take up new challanges in science and technology. Some of the new equipments proposed to be acquired are: servo hydraulic machine, CNC hydraulic press, pilot plant for mineral processing, rolling mill and furnance etc. For accomodating new facilities and equipment additional building (7500 square meters) is needed.

Testing and other Facilities

Materials; Physical & chemical testing; Building materials; Energy conservation; Metallurgical industry

Major Programmes to face the Future

Programme	End Outputs	Rationale
Building materials	Wood substitute like polymer based door shutters	Utilisation of waste materials for making value added products
	Low cost building materials like sisal cement, roofing sheets hollow/solid cement concerte blocks fly ash bricks	
Metallurgy and Material Sciences	composite materials such as Metal Matrix Composites	Capability building
	Innvovative metallurgical and material processing techniques	Trouble shooting and technical advice
	Quality upgradation of metal based industry in rural/ tribal sectors	Relevance for local S&T needs
	Tribological studies related to mining and farm implements	Technology assimilation
Minerals	Beneficiation of low grade minerals i.e. siliceous rock-phosphate, tin, nickel etc.	Development of indigenous resource base

NEW PROCESSESS/ PRODUCTS AVAILABLE

SECTOR	PROCESS/PRODUCT
Building Materials/Components	Ceramic tiles from pyrophyllite
Materials and composites	Hard ferrites from blue dust

FINANCIAL RESOURCES

(Rs. in Lakh)

		Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1.	CSIR (X)	**157.34**	**171.75**	**203.85**
2.	Extra Budgetary Resources (EBR- Income from outside)			
	a) From Private (Industry) b) Public (Govt. Agencies) c) Others	17.02	37.22	50.40
	Total (2) (Y)	**17.02**	**37.22**	**50.40**
	GRAND TOTAL (X+Y)	**174.36**	**208.97**	**254.25**
	Ratio (Y/(X+Y))	**9.8%**	**17.8%**	**19.8%**

MANPOWER: as on 31/03/92

Group IV	43	Group II	14	Group V	-
Group III	19	Group I	5	Administrative	33
				Non-Tech. (Class IV)	10
Total	**62**		**19**	Total	**43**

Grand Total 124

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):
= 62 : 19
= **1 : 0.31**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):
= 62 : (19+43)
= **1 : 1**

CENTRE FOR CELLULAR AND MOLECULAR BIOLOGY (CCMB), HYDERABAD
(Established 1977)

Although the centre for Cellular & Molecular Biology (CCMB) was set up in 1977, it became fully operational in 1982. The centre is created to provide centralised facility for new and modern techniques in the interdiscipilinary areas of biology, to carry out basic and fundamental research in frontier areas of modern biology and to seek potential applications of this work as well as to carry out exploration work in modern biology with a view to aid the development of biotechnology.

SIGNIFICANT ACHIEVEMENTS (1985-91)

* The institute has created infrastructural facilities in multidisciplinary areas of biology and is recognised as one of the best laboratories in India.
* It has been able to understand some of the basic problems of human malignancies. Amplification of certain oncogenes in malignant tissue of human patients and organisational changes (rearrangements, translocation) have been observed in several human mammory tumours.
* Studies have indicated that number of factors including policyclic aromatic hydrocarbon affect the lens proteins, the crystallins, leading to opacity of the eye lens known as cataract. Polycyclic aromatic hydrocarbon factor is important in Indian context.
* The pro U gene locus in E.coli has been found to consist of three genes organised as a single operon. It encodes an osmotically inducible active transport system for uptake of compounds and plays an important role in adaptation to osmotic stress. This information can be of significance to improve crop yields in drought striken areas, and of high soil salinity.
* It has been shown that proteins containing signal sequences can only adopt the beta structure in hydrophobic environments.
* The application of a Bkm - derived probe for DNA finger printing has been standardised and is currently in use in forensic cases. This technique has been generally accepted by Indian courts.

- A fish fry hatchery system which is the only one of its kind in India has been developed, work has also been carried to optimisation of the composittion of fish feeds for maximal growth.

EIGHTH PLAN PROPOSALS (1992-97)

The centre is engaged in basic and fundamental research in modern biology. Some of the key areas of research are relatd to problems of human health (malignant transformation, cataract); agriculture (osmoregulation in plants), DNA finger printing) and fish breeding. The centre is one of the three best training centres in India in the field of biology. The institute has gained international recognition and is included by UNESCO in their global biological reserch laboratories net work.

HIGH PRIORITY MAJOR PROGRAMMES

In the area of biophysics and biochemistry, the study will be conducted to understand molecular aspects of cataractogenesis in the eye lens, and for isolating compound and its effect on lens dysfunction; structure and conformation of nucleic acids and proteins and their interactions so as to pickup specific cases that play a role in biologically important process; Molecular mechanism of secretion and transport of proteins; and molecular basis of membrane structure and function for better understanding in terms of environment orientation and location of membrane bound probes and proteins.

In molecular biology it is proposed to study some of the basic problems in the area of developmentally regulated proteins, protein degradation; seminmal plasmin; ribouncleases, molecular basis of sex determination; gene regulation in micro organisms, and genetics of osmoregulation, and genome analysis.

In cell biology it is proposed to generate new knowledge to understand the basis of cell division and malignant transformation; effect of starvation on intestinal cells; internuclear connections and reproduction.

In the area of evolutionary biology, the thrust is to carry out basic work on microorganisms of Antarctica, molecular evaluation, DNA sequence analysis; and mathematical modelling of genetic and metabolic processes;

Other Plan Activities:

Distributed Information Centre

Besides carrying R & D work, it is proposed to provide DNA finger printing and related analysis to crime investigating agencies in rape, murder and other violent cases including identification of multilated dead bodies and to prepare and keep records of DNA finger prints of potential criminal. It is also proposed to provide DNA profile analyses and related techniques in criminal and family matters.

The CCMB has a major training centre and Distributed Information Centre of the Bioinformation network , concerned with collection and dissemination of international information in biological research. It is engaged in collection of several rare strains of experimental animals. It is proposed to continue this activity in a much larger scale and this requires additional space.

Testing and other Facilities

DNA fingerprinting facility; Fish feed and prawn feed

Major Programmes to face the Future

Programme	End Outputs	Rationale
Bio-physics & Bio-chemistry	No well defined target	These are frontier areas of research in biological Sciencs
Molecular Biology	Development of E. coli for Expression	To keep pace with the current status, basic work is being done in these important areas
Cell Biology	Modulation of effect of hormones	
Genetics & Evolution	To understand the basis of sex determination	

FINANCIAL RESOURCES (Rs. in Lakh)

			Actuals 1990-91	Actuals 1991-92	S.E. 1992-93
1.	CSIR (X)		763.00	664.75	623.29
2.	Extra Budgetary Resources (EBR- Income from outside)				
	a)	From Private (Industry)			2.25
	b)	Public (Govt. Agencies)	59.25	208.90	164.00
	c)	Others			
		Total (2) (Y)	59.25	208.90	164.00
	GRAND TOTAL (X+Y)		822.25	873.65	789.54
	Ratio (Y/(X+Y))		7.2%	23.90%	21.0%

MANPOWER: as on 31/03/92

Group IV	70	Group II	98	Group V	5
Group III	96	Group I	74	Administrative	56
				Non-Tech. (Class IV)	6
Total	166		172	Total	67

Grand Total 405

a) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr.II):

= 166 : 172

= **1 : 1.04**

b) Ratio = (Gr. IV + Gr. III) : (Gr.I+ Gr. II + Others):

= 166 : (172+67)

= **1 : 1.44**

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