

National Chemical Laboratory: Transformation into a Global R&D Platform¹

*The Purpose of this Laboratory is to Advance Knowledge and to Apply
Chemical Science for the Good of the People*

- Inscription at Entrance to NCL

Introduction

The appointment of Dr. R.A. Mashelkar as Director of India's National Chemical Laboratory (NCL) in June 1989 triggered off a process of organizational transformation that was to place NCL in the forefront of publicly-funded research organizations seeking opportunities across the country's borders. This case describes the process of this transformation and the interesting issues it generated.

History & Culture

NCL was one of 40 national laboratories constituting India's Council for Scientific & Industrial Research. Founded in 1949, NCL was one of the earliest CSIR laboratories. The CSIR laboratories were created out of a deep conviction of the government of India under Prime Minister Jawaharlal Nehru that science and technology would enable the transformation of India from a poor nation to a position of economic and social advancement. As Prime Minister Nehru said at the founding of one of the laboratories:

I think that in paying special attention to scientific and industrial research during the last four or five years, we have laid a solid foundation on which we could build a splendid edifice of New India These research laboratories are just symbols to focus our attention on newer aspects and to raise the country as a whole. I do not view these laboratories from the consideration that they will handle particular problems which lie within their scope. I look upon them as temples of science built for the service of our motherland.²

CSIR laboratories were set up in a variety of disciplines including Physics, Metallurgy, Botany, Mechanical Engineering, Electrochemistry and Electronics. Some other CSIR laboratories were also set up to develop and exploit the resources of particular regions of India and were christened as Regional Research Laboratories.

¹ This case has been written by Prof. Rishiksha T. Krishnan, Indian Institute of Management, Bangalore 560 076, India. It draws on material contained in *Response of National R&D Laboratories to Environmental Change: A Study of Five Indian Industrial R&D Laboratories* (Unpublished doctoral dissertation, IIM Ahmedabad, 1996). It is not intended to demonstrate either effective or ineffective handling of a managerial situation. Not be reproduced in any form without the permission of the author. © 1998 Rishiksha T. Krishnan.

² From a speech at the inauguration of the Central Salt Research Institute, Bhavnagar, April 10, 1954. Reproduced in *Saga of Sagar* (Bhavnagar: CSMCRI, 1992), p. 3.

The CSIR was set up as a registered society with the government as its sponsor. The intention was to allow the CSIR enough flexibility to function without bureaucratic interference, yet at the same time maintain links to government policy and programmes and have access to government funding. Over the years, however, the CSIR became more an appendage of the government and subject to many of the constraints of governmental functioning.

The CSIR was also the subject of much criticism for its apparent lack of tangible achievements. As a result, the government reviewed the functioning of the CSIR on a number of occasions during its history. A persistent problem, reflected in many of the review reports, was the question of the objectives of the CSIR. While some people believed that the role of the CSIR was to “solve the problems of the people through the application of science and technology”, others were of the view that the CSIR should develop technologies for new products and processes that could be used by Indian industry. A third group believed that the CSIR should concentrate on doing first-rate work in the different fields of science and technology and not be overly concerned with the tangible outcomes of this endeavour. This group believed that such high quality work was bound to result in visible results sooner or later.

NCL was considered to be one of the premier laboratories of the CSIR. In its early days, the laboratory concentrated on research in conventional areas of Chemistry with some focus on application areas of importance to the country like dyes. At the end of its first decade, the laboratory had an impressive record of scientific publications but not much direct interaction or links with industry. The Indian chemical industry was also in a state of infancy during this period.

During the 1960s and early 1970s, as India's import substitution-oriented economic policy became more pronounced, there was increasing pressure on laboratories like NCL to become more involved in solving industry problems and to develop new technologies for industry. The chemical engineering discipline was strengthened within the laboratory and competencies in building pilot plants and scaling up technologies were developed. Limited success was achieved in developing and transferring such technologies to industry. During this period, high quality basic scientific research continued to be encouraged.

In the second half of the 1970s and the 1980s, the laboratory focused on areas like catalysis and polymers, and in developing advanced competence in these areas. The laboratory implicitly decided to get out of routine problem-solving for industry and concentrate only on those areas where they could make a potentially big impact. In its focus areas, NCL was believed to be at the cutting edge of technology. However many of the technologies developed did not reach implementation on an industrial scale, due to the absence of funds for setting up pilot plants and scaling-up, and Indian industry's lack of confidence (except in a few cases) to make the investments to implement these technologies. In most cases, industry had access to proven technologies from foreign sources and lacked the expertise to fully evaluate or develop further the technologies developed by NCL.

As a result of the above approach, NCL developed both a strong scientific base (demonstrated through the large number of research articles in leading refereed international journals) and a strong application focus, at least on a laboratory scale. The dominant view of senior scientists in the laboratory was that good science and good technology go together and positively reinforce each other. However, links with industry internationally were poor or non-existent and patenting outside India not taken seriously. NCL was a big fish in a small pond and had thus far refrained from venturing into deeper waters.

Like other CSIR laboratories, NCL had to follow governmental regulations regarding recruitment and selection, pay scales, administrative procedures, and accounts and auditing processes. Thanks to increasing public criticism and review of its functioning, the CSIR had become much more regimented and little discretionary power was available at the laboratory level. Government fund allocations were enough to cover salaries and minor expenses but were inadequate to launch major new research programmes or make major capital purchases.

In order to strengthen links between the CSIR laboratories and Indian industry, the 4th Review Committee of the CSIR recommended in its report of December 1986 that the CSIR be required to raise at least one third of its earnings from external sources. While no specific target was set for each laboratory, there was pressure on the individual laboratories to increase their external earnings. As an incentive, laboratories were permitted to create a laboratory reserve fund out of the retained external earnings and to decide how to utilise the laboratory reserve, subject only to some broad overall guidelines.

NCL's Strategy for the 1990s

Mashelkar became the director of NCL in June 1989. As director he was the chief scientist and head of the laboratory. Mashelkar had joined the laboratory about 13 years earlier after a stint at the University of Salford and, earlier, a Ph.D. from the University of Bombay. Mashelkar had a strong reputation as a scientist and science-manager even before he assumed charge; he had been a member of the Science Advisory Committee to the Prime Minister of India.

Mashelkar set out his agenda for the laboratory right at the beginning of his tenure. Identifying international competitiveness in technology development and excellence in basic research as the twin objectives for the laboratory, Mashelkar announced his intention to, *inter alia*, recruit and retain the best talent, make promotions performance-based, provide incentives to encourage team efforts, support crazy ideas in the hope that they would lead to major breakthroughs, and improve the laboratory's management.

Creating new infrastructure

The first challenge Mashelkar faced was to improve the infrastructure within the laboratory. Luckily for him, a new scheme of the World Bank under its Industrial Technology Development Programme (ITDP) had provision for lending to institutions such as NCL. NCL applied for a loan to upgrade its facilities in the areas of catalysis, polymers, and organic chemicals and to set up state-of-the-art characterization, analytical and pilot plant facilities. This was perhaps the first time that a publicly-funded research institution in India had applied for such a loan. As the loan had to be repaid from the external earnings of the laboratory, this clearly signalled confidence in, and commitment to, remunerative industrial research in the future. The loan was finally granted in 1992.

Business planning and marketing

Mashelkar realised that a more business-oriented approach to planning technology development activities and a clear marketing strategy were important. NCL had a research planning department and had been one of the laboratories at the forefront of adopting project-based accounting, monitoring and control in the CSIR. However, this planning still lacked a commercial orientation.

To implement the new approach, in 1990, Mashelkar set up a business planning and marketing group directly attached to his own office. Called the Project Planning and Development (PPD) unit, this initiative was designed to give a more focused thrust to the laboratory's interaction with industry, and to improve coherence between different activities. The PPD unit was staffed by a small team of existing and newly hired staff which had industry and consulting experience.

The formation of the PPD unit was initially resented by some scientists due to a belief that good chemistry would, on its own, lead to good technology. But it was pointed out to scientists in the laboratory that some (research-wise) very interesting new routes discovered to synthesize carbamate pesticides were uneconomical. In another case, it was demonstrated that the (then) recently announced decontrol of molasses had rendered a number of promising new ideas unviable. This evidence began to convince even those who were initially skeptical.

The functions of the PPD unit were to:-

- relay to scientists information on technological and marketing requirements;
- bring together companies and appropriate NCL divisions/scientists;
- arrange for appropriate contract research work to be undertaken by NCL;
- act as principal commercial agent for marketing NCL research and technology;
- maximize returns from contract research and consultancy.

PPD unit staff followed the market by interacting with industry, scanning patent literature, and following international technology and business trends. They did a pre-research appraisal of new projects, products and processes from a technical and commercial angle. All new research proposals and contracts were screened and evaluated by the PPD unit before being sent out to client companies, to ensure that returns to NCL were maximized.

This effort culminated in a major rationalization of the existing projects and preparation of an R&D and business plan in 1993. As part of this exercise, existing applied research projects which were unlikely to result in any exploitable technologies were shelved. In contrast, projects likely to generate additional revenues were given additional resources. Internal funds were reserved for outstanding projects or as seed money. As a result, scientists now had to align their research work more closely with the interests of potential clients.

Also in 1993, a grant under the ITDP enabled NCL to obtain the services of Generics, a UK based consultancy firm, for the development of a management system that integrates R&D activities with business strategy and marketing.

Support for “Kite Flying Ideas”

Mashelkar believed that breakthroughs in science will not happen unless “crazy” ideas are supported, no matter how outlandish they appear to begin with. A new scheme to support such “kite flying ideas” was therefore started in 1990. Under this scheme, support was given to laboratory scientists to work on such ideas that might not fit in with the current paradigm of work in the laboratory and that might not get external funding. Such awards were made on a competitive basis. Mashelkar was prepared to spend up to one fourth of the retained external earnings of the laboratory on such ideas if sufficiently innovative proposals were to come up.

Support for Technology Development – Creation of the NCL Research Foundation

Mashelkar realised that a major lacuna was the absence of awards to recognise outstanding technology development which usually depends on team effort. He proposed to give cash awards for the most significant group efforts every year. However, there was no provision to give such awards in the government rules applicable to laboratories like NCL. As an alternative, Mashelkar therefore proposed the setting up of an independent trust that would raise funds from other sources and give awards out of the earnings of the trust. This idea was initially opposed by the CSIR head office, fearing the possibility of diversion of government funds to this trust. Ultimately, however, Mashelkar’s persistence prevailed and the NCL Research Foundation was set up in 1991 with financial contributions from industry. The Foundation instituted awards for outstanding scientific work, best technology commercialized, the division with the highest external earnings from industry, and new initiatives by the R&D support system. A scheme to give gold medals for obtaining US patents was also introduced.

Response to Economic Liberalization

Soon after the announcement of the new industrial policy in 1991, Mashelkar put together a group of senior scientists to analyse the impact of the new policy on R&D at NCL. The group tried to work out the short, medium and long term effects of the policy on the Indian chemical industry and publicly-funded R&D institutions in the chemical sector. The analysis identified opportunities for institutions like NCL in such an environment. It also noted that the macro changes would have to be matched by changes in attitudes, plans and programmes at the laboratory-level and stated NCL's resolve to be responsive, viable and productive. Their analysis also strengthened the conviction that in the changed scenario, only technically and commercially competitive technology with global markets would be relevant.

Internationally, the group observed that corporate R&D was becoming more multinational. Governments were beginning to support multi-country initiatives and hitherto "national" projects were becoming international. They felt that multinational corporations realise that good ideas can come from any source and would therefore be willing to look at ideas from India as well. From this, they wondered, "In areas where Indian industry is fragmented and has no capability to take a new product, through all the stages of the innovation chain, to market on a sufficiently large scale, why not look at the MNCs?"

The China Project

At the instance of the Export-Import Bank of India, Mashelkar decided to participate in the global bidding for a project to strengthen the R&D capabilities of two chemical R&D institutions in China. NCL obtained the contract in competition with consultancy majors such as Arthur D. Little. This turned out to be a major learning opportunity for the laboratory in terms of understanding R&D management in a different setting, earning foreign exchange and realizing some of the limitations of the laboratory's status as one of the constituents of a non-profit government-controlled society. In fact, NCL scientists felt that they spent much more time on procedures than they spent on executing the assignment! But the assignment gave them the confidence to take on international consulting projects and had side-benefits such as the building of new relationships with Chinese institutions and researchers.

Recognising the Criticality of Information

As a recognition of the importance of information services to an R&D institution seeking to be a global R&D platform, Mashelkar created a separate Scientific and Management Information Services unit in 1993. A senior scientist (rather than librarian) was put in charge of this unit and he reported directly to the director of NCL. This unit specialises in accessing international databases and on-line patent information.

Personal Initiative to open doors

Mashelkar used his reputation as a scientist to get speaking opportunities at the R&D centres of leading MNCs such as GE and Du Pont to focus on the excellence of the scientific R&D work being done at NCL. This often led to discussions with business development managers of these corporations and finally to contract research opportunities. Mashelkar also used prestigious Indian and international lectures to communicate the philosophy of the laboratory, its achievements and its particular relevance in the 1990s.

In technology marketing, Mashelkar played a key role in persuading (with appeals to national and corporate pride and prestige) major Indian companies like Reliance Industries to become NCL's partner in developing new technologies (in this case for the development of a new environment-friendly zeolite catalyst to replace the conventional hydrofluoric acid catalyst used internationally in the manufacture of LAB, an important intermediate for detergents).

Within the laboratory, Mashelkar used media like the in-house magazine and speeches on laboratory occasions to communicate his philosophy and ideas.

Protection of Intellectual Property Rights (IPRs)

Mashelkar and his team realised that a strategic appreciation of the role of IPRs was critical to be an internationally competitive technology source. They decided to put in place a system which would secure strong Indian/international patent rights for new products and processes, and manage and market the patent portfolio. They set guidelines to ensure that identification and valuation of patent rights was done early in the innovation process. They stressed documentation of the innovation process to facilitate filing patent applications. An internal mechanism was created to assess the elements of novelty, non-obviousness and potential economic benefit which are the essential prerequisites of a patent. New R&D projects were to be initiated only after a world-wide patent search in the area. Medals were instituted for scientists obtaining U.S. patents. The cost of patenting was sought to be built into the R&D costs to be recovered from contracts. Funds were also set aside to establish and protect IPRs.

Setting up a Commercial Arm

Mashelkar was keen that NCL set up a commercial arm that would give greater flexibility and vitality to marketing the laboratory's knowledge base. This was seen as a small group of highly qualified professionals (marketing, finance, law, etc.) who would work towards the common goal of maximizing the laboratory's returns. However, due to procedural constraints, this could not be immediately translated into reality.

The Results

The first major breakthrough was the export of technology for a high tech catalyst to a Dutch multinational in 1990. NCL was also able to obtain contract research projects from Florafrafrica, Neste, Du Pont, GE and FMC. Association with MNCs was believed to have resulted in upgradation of experimental/analytical skills and techniques to the international state-of-the-art, improved patent literacy and better project review techniques. With the rapid growth of Indian industry in the early 1990s, NCL also forged closer links with some Indian companies.

NCL's external earnings doubled between 1989-90 and 1994-95 (See Exhibit 1). More impressively, the earnings from sponsored research by industry (both Indian and international) rose four-fold over the same period. By 1994-95, NCL was filing more than ten U.S. patent applications every year and getting about 9 patents accepted every year (See Exhibit 2). In the year 1995, NCL was the recipient of eight of the nine U.S. patents awarded to CSIR laboratories. NCL was also able to maintain a steady stream of published work with 234 research papers published in the year 1994.

In recognition of his pioneering efforts at NCL, in May 1992, Mashelkar was appointed Chairman of a CSIR committee to recommend measures (structural changes, changes in staffing patterns and incentives) to improve marketing of the CSIR "knowledgebase". In many ways, NCL was being seen as the trendsetter for the Indian public R&D system.

Outstanding Issues

In spite of these impressive achievements, some problem areas remained. The first of these was maintaining a balance between the basic, applied research and development work done within the laboratory, and between work done for MNCs and Indian industry. The second was penetrating the web of patents existing in many of NCL's thrust areas. The third was attracting and retaining qualified scientists and technologists. Apart from these, there were some problems arising from the regulatory structure governing the laboratory.

Maintaining a Balanced Portfolio of Projects

One of Mashelkar's oft-quoted statements was "Exploration without exploitation is sterile". While some scientists agreed with this and believed that good technology is science-based, excellent technology needs good basic research, and that the laboratory was achieving a fine blend of these, others felt that commercialization had gone too far. Many in the latter group saw the generation of scientific knowledge as a major challenge and its application as a technician's job. Among these were some senior scientists with an outstanding record in their respective areas of research. There was also a feeling among a section of scientists inside the laboratory, and among influential outsiders, that the laboratory had strayed too far from its basic objectives by becoming a provider of research services to MNCs rather than Indian industry.

However, the top management of the laboratory believed that contract research for MNCs had actually strengthened objective-oriented basic and applied research because many contracts stopped at the research stage. They cited the continuing stream of research publications in leading journals as proof that basic research had not been undermined. They also pointed to some senior scientists within the laboratory who had been able to publish in leading journal, do research work leading to patentable technologies and be involved in consulting and sponsored R&D projects at the same time.

Sensitive to societal pressure, in early 1995, Mashelkar stated in public that NCL's charter was to serve the nation and make the industry globally competitive. He announced that NCL would seek to maintain a balanced portfolio with about two-thirds of its work undertaken with Indian firms.³

Penetrating the web of patents

NCL was beginning to run into constraints caused by the web of patents created by MNCs. NCL lacked the resources to create such a web on its own or to licence patents held by others. Mashelkar has given an interesting example of this predicament:-

Exxon and Hoechst today hold nearly 50% of over 400 global patents on metallocenes, a catalyst which will have tremendous impact in future on polyolefin polymers made by the conventional Ziegler-Natta catalysts. Exxon even sues new companies entering this field for violation of their patents to pre-empt any future competition in this area. NCL is now faced with an interesting difficulty. It has a novel innovation in metallocenes but it is finding it difficult to break the fortress of 400 strong patents!⁴

Attracting and Retaining Qualified Professionals

While NCL had not found it difficult to retain senior scientists, inducting enough qualified young scientists and retaining them in NCL was a major challenge. A part of this problem could be attributed to CSIR restrictions on recruitment and cumbersome procedures that could take as long as a whole year to fill a position. The larger problem was the decreasing attractiveness to young Indians of science as a career – they had other more lucrative and glamorous options such as becoming a part of India's booming, internationally-oriented software industry.

Other Problems

NCL faced a number of problems in carrying its strategy ahead. Many of these arose from the constraints arising from being part of a governmental system that was unsuited to the spirit of enterprise shown by the laboratory in trying to penetrate international markets. These included (i) a conflict between the requirements of clients for

³ R.A. Mashelkar, "India's Emergence as a Global R&D Platform: The New Challenges and Opportunities," Lala Karamchand Thapar Centenary Memorial Lecture, Patiala, March 4, 1995.

⁴ *Ibid.*

confidentiality and the norms of public accountability and information disclosure; (ii) prejudices against the use of agents and the lack of an operating or marketing base in international markets; (iii) ignorance of environmental, safety and occupational health regulations of international markets; and (iv) delays caused by rules requiring obtaining approvals from multiple government agencies. Besides, reduced budgetary support from the government precluded the significant investments needed to create new facilities.

Post Script

Even as he was grappling with these problems and the other challenges of sustaining and consolidating NCL's position as a global R&D platform, in June 1995, Mashelkar was appointed Director General of the CSIR, and ex officio, Secretary to the Government of India, Department of Scientific & Industrial Research. In this position it was expected that he would transfer the culture and innovations at NCL to the other 39 laboratories in the CSIR system.

Exhibit 1

National Chemical Laboratory : Income (1987-95)

Year	Sponsored Research from Industry	Consultancy Services	Contract Research from Government	Premia/Royalty	Total	Funding from Govt. through CSIR
1987-88	9.6	1.0	5.3	0.6	16.5	71.0
1988-89	6.7	1.5	18.5		26.7	78.1
1989-90	6.8	2.1	24.8	2.8	36.5	89.0
1990-91	7.6	1.7	20.7	5.6	35.7	98.5
1991-92	13.6	6.7	14.8	6.0	41.1	109.0
1992-93	8.7	3.0	24.0	3.5	39.2	112.6
1993-94	20.5	2.5	24.5	5.6	53.0	115.4
1994-95	28.5	3.4	35.2	6.7	73.8	127.9

All figures in Rs. million. Figures when added may not match totals due to rounding errors.

Exhibit 2

National Chemical Laboratory : Patents (1987-95)

Year	Indian			Foreign		
	Filed	Accepted	Sealed	Filed	Accepted	Sealed
1987-88	19	21	14	-	-	-
1988-89	26	5	23	10	-	1
1989-90	27	3	9	14	-	-
1990-91	41	9	8	12	-	3
1991-92	56	7	5	7	1	3
1992-93	42	10	6	16	-	8
1993-94	49	NA	11	11	NA	9
1994-95	45	NA	6	16	NA	9

NA: Not Available