Global chemistry

NCL at Pune has become a source of globally competitive products, processes and technologies

Photos: Palashranjan Bhaumick

Mashelkar believes in boundaryless labs which lead to creation of wealth and knowledge

What do General Electric, DuPont, Unilever, Neste OY, Akzo, Ciba-Geigy, Solvay Enzymes, Genencor, FMC and other companies from South Africa, Spain and Germany, besides government agencies from Indonesia, China and Ivory Coast have in common with a host of Indian companies including Reliance, Adarsh Chemicals, Godrej Agrovet, EID Parry, Torrent Pharma, Globe Organics, Tetragen, Hindustan Polymers, GSFC, Excel, Dr. Reddy's Labs, Indian Oil, Indian Organics, GAIL, Voltas, PIL, Astra-IDL, Godrej Soaps, Armour Chemicals, Straw Products, Ficom Organics, Thermax, Hindustan Organics, CETEX Petrochem, Bharat Petroleum, Hindustan Lever and SOL? They have sought technical solutions to their design and manufacturing problems from a CSIR laboratory in Pune, the National Chemical Laboratory.

NCL has long been known as a centre of excellence in chemical research. The tradition established by outstanding chemists who led NCL from 1950 to the late 1980s that included McBain, Finch, K.Venkataraman, B.D. Tilak and L.K. Doraiswamy took it to these heights. Today NCL alone publishes more than 250 research papers in a year in international journals (by comparison Indonesia publishes 60 papers). NCL also holds the maximum number of patents in India, and 50 to 60 patents are filed by it each year. Last year, over 20 US patents were registered. Considering that US patents have the most rigorous procedures to prove novelty and utility, to hold a US patent is a matter of great international prestige.

The remarkable thing about NCL is not that it has changed according to the global technology regime but that it has been able to foresee it. The change started a few years prior to the events in 1991 in Berlin or Moscow or New Delhi. In his address to his 500-odd colleagues when he took over as NCL's new director in 1989, Dr Ramesh Mashelkar said that his aim is to turn the laboratory into an international chemical laboratory. The outlook towards industrial research, technology marketing and consultancy underwent a sea change after that.

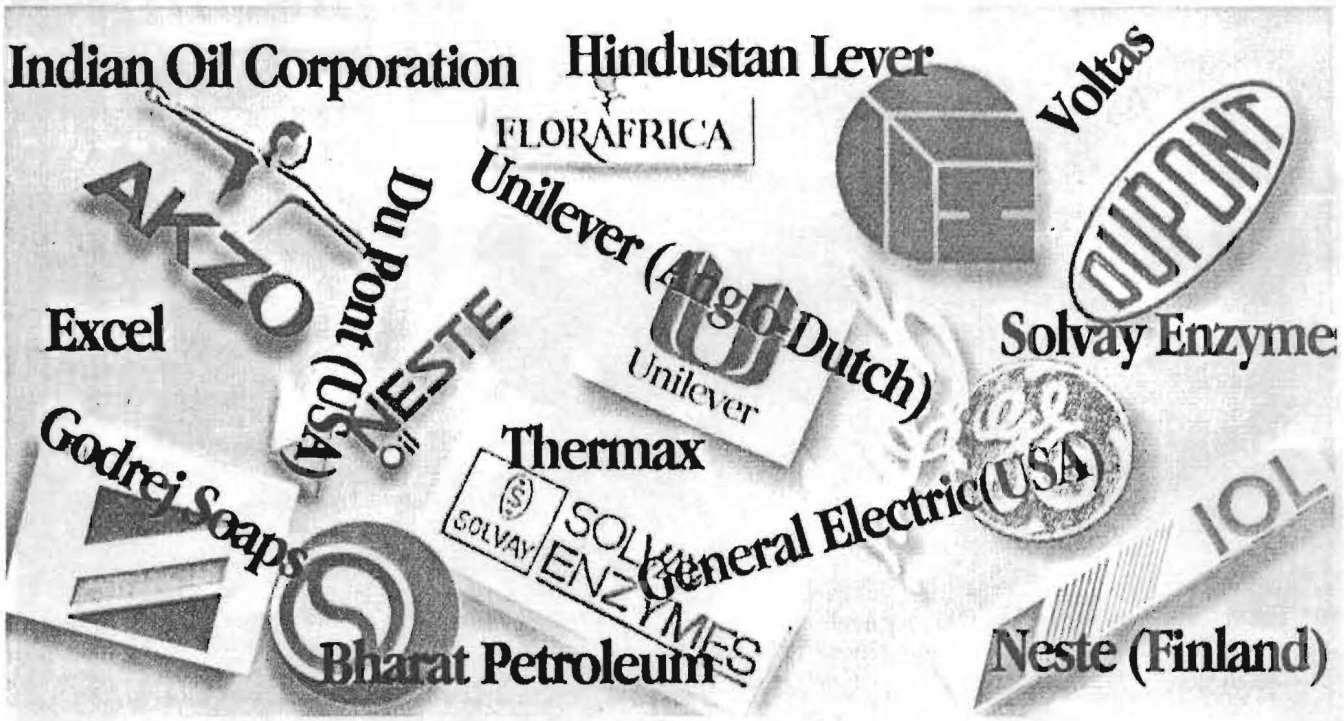
NCL's technology marketing group was set up with well-defined functions. Professionals in law, accountancy and marketing were hired and, using grants from the World Bank, they were trained in internationally well-known technology marketing agencies. People were sent to acquire first-hand knowledge of how the cut-throat game of patenting is played internationally. Training programmes in management, etc, were conducted for the scientific staff by management gurus like Sharu Rangnekar. Special awards were instituted, to be awarded on the

foundation day to all those who were successful in registering US patents. Schemes were worked out for providing monetary incentives to scientists by retaining some of the money earned through royalties, international contract research and consultancy. The results were so remarkable that the director-general of CSIR formed a committee of CSIR directors chaired by Mashelkar to suggest similar steps in the entire CSIR set-up.

The result was the report produced by the committee in January 1993, entitled "Creating an enabling environment for commercialisation of CSIR knowledge base: A new perspective." Besides what had already been attempted at NCL, the committee had some radical proposals: scientists should be allowed to go on a sabbatical to work in consultancies, financial institutions and industries; scientists should be permitted to function on the board of directors of private sector companies. It was also suggested that CSIR, in lieu of royalty payments, be allowed to take equity in industries which licensed CSIR technologies, and CSIR labs be allowed to set up commercial arms to market their technologies, services and hi-tech products. Immediately a new committee was set up to work out the implications of these recommendations and suggest measures for their implementation. The committee, which was headed by Lovraj Kumar and following his demise by Mashelkar, has just produced its report. An exercise is also on to change the bye-laws and statutes to make them systemic rather than being left to the discretion of individual directors.

But there is some concern that while weaknesses in marketing may be corrected by these changes, it might destroy the atmosphere for basic science in CSIR labs. Mashelkar ably discounts this fear by giving the example of NCL. "Without high science there cannot be high technology and CSIR cannot become CIR," he says. For example, there are people like Dr B.D. Kulkarni who are doing esoteric work in nonlinear dynamics, fractals and chaos theory and their application to chemical and biological systems. His expertise was used in important work in polymer engineering and catalysis. Similarly, cutting edge work is being done by Dr Ganguly on Langmuir-Blodgett films for developing new materials which will have an effect on the much sought after nano-technology. Top-notch basic work is also being done in organic synthesis which will have an effect on organic synthetic technology, etc.

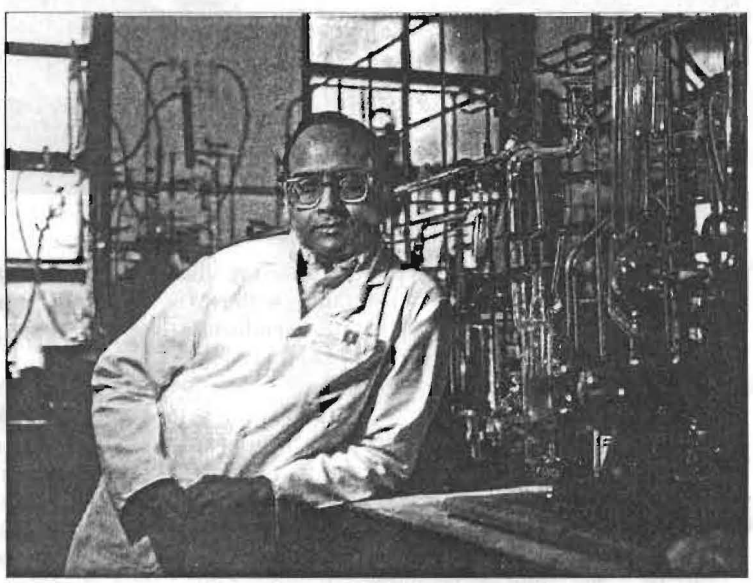
Mashelkar continues to publish basic papers in chemical engineering science. After receiving his PhD at University Department of Chemical Technology under Prof M.M. Sharma, he went on to set up from scratch a top-notch group at Salford, UK, in polymer engineering starting with the study of non-Newtonian fluid dynamics. Dr Paul Ratnaswamy, head of the catalysis group at NCL, who has a large number of technologies and US patents to his credit, continues to do basic work in catalysis that has received worldwide recognition. There are many other examples. In fact, NCL made the front page of *The New York Times* in March 1990 — a first for Indian science — for its pioneering work on tissue culture that allowed bamboo to flower in a few days instead of many years.



This vision of the correct balance between science and industrial research, however, requires R&D management of a very high class, which NCL has been fortunate in having in Mashelkar. In fact, he has been a consultant for Unilever on technology strategy and R&D management and has been repeatedly given assignments by the World Bank to advise on restructuring R&D in China and Indonesia. Another innovation at NCL is the concept of 'kite-flying projects'.

Here projects that are too 'crazy' for any funding agency to consider will be financed by a special fund at NCL. Mashelkar believes that many breakthroughs and new insights come through such projects. After all, managing science and innovation is like managing creativity, a contradiction in terms, but something that governments and corporations always try to do. There is no formula and there cannot be any extremism and dogmatism.

Another feature of NCL that helps it do good science and even risk-taking in technology development is the research programme. Right now, there are about 200 students carrying out projects for their PhD at NCL. They are registered at other universities but come to NCL for their work. Many senior scientists give PhD students scientific work or risky technology development projects which they cannot do themselves for lack of time or funding. This leads to a lot of basic research papers and even technology advances. Mashelkar proudly points out that out of 21 people who are going to be honoured for acquiring US patents this year, six are PhD students!



Shivram is creating much sought after polymers

One of the major activities of the catalysis group headed by Paul Ratnaswamy is in developing 'green technologies', ie technologies that involve catalysts and chemicals that are eco-friendly. One such technology has been a new zeolite (a kind of clay) catalyst for Linear-Alkyl-Benzene(LAB). As this story goes to Press, the NCL patented technology is being tried out on a semi-commercial scale of 500 tpa at the Reliance Industries complex at Patalganga. The process promises to yield increased LAB production and better product characteristics. The present technology worldwide uses hydrofluoric acid as a catalyst, which is highly corrosive to the plant and dangerous to the environment. Once proven on a commercial scale, there is excellent potential for global export of this NCL-Reliance technology, besides the fact that, by 2000 AD, India itself is projected to be the biggest global player in LAB.

Adarsh Chemicals is putting up a plant at a cost of more than Rs100 crore to produce the highly valued tetrahydrofuran, gamma-butyrolactone and 1,4 butanediol based on NCL technology. It is superior to the state-of-the-art Davy-Mckee process and is far more versatile. Similar new and more efficient green technologies have also been developed in p-diethyl benzene for Hindustan Polymers, methyl-ethyl ketone for CETEX Petrochem, cyclohexanone oxime for GSFC, diethyl benzene for Polychem, etc.

It is for this reason that new catalyst technology has been contracted to be developed by NCL for GE in speciality chemicals, DuPont in speciality chemicals, FMC for a pesticide intermediate, and catalyst know-how for Neste OY and AKZO. NCL has successfully transferred the technology for commercial production of various catalysts to United Catalysts India, which has been winning hi-tech export awards.

Similarly, the organic synthesis group has developed processes for manufacturing epibatidine, a painkiller with a potency 200 times higher than morphine. The current method involves extracting it from the skin of an Ecuadorian frog — a total of 750 frogs yield only 24 grams of the pure substance. NCL's process patent application is pending and is being eagerly sought by a South African company. A new process for biotin, one of the B-complex group of vitamins which is of immense importance to animal health and nutrition, has been developed. It does not use the dangerous phosgene gas that is used by other processes and is even better than the one developed by Nobel Laureate Prof Corey of Harvard University. Similarly, ranitidine, an anti-ulcerant which is the world's largest selling drug, is currently manufactured using nitromethane and alkali which form an explosive combination or using the hazardous methyl isocyanate of Bhopal infamy. A new NCL process using zeolite catalyst has led to a safer manufacture of ranitidine. A complex 17-step process for brassinosteroids, a plant growth hormone, was developed by NCL. The product is currently being marketed by Godrej Agrovet.

There are many such technology stories in every lab of NCL. For example, there are many new engineering plastics and adhesives being developed by the polymer group headed by Dr Shivram, who left the petrochemical giant IPCL and chose to head the polymer chemistry group in NCL. There is a new additive that will reduce the drag in pumping oil through pipelines and a super absorbent gel called Jal Shakti which is finding applications in diapers and sanitary napkins, though not in agriculture as expected earlier.

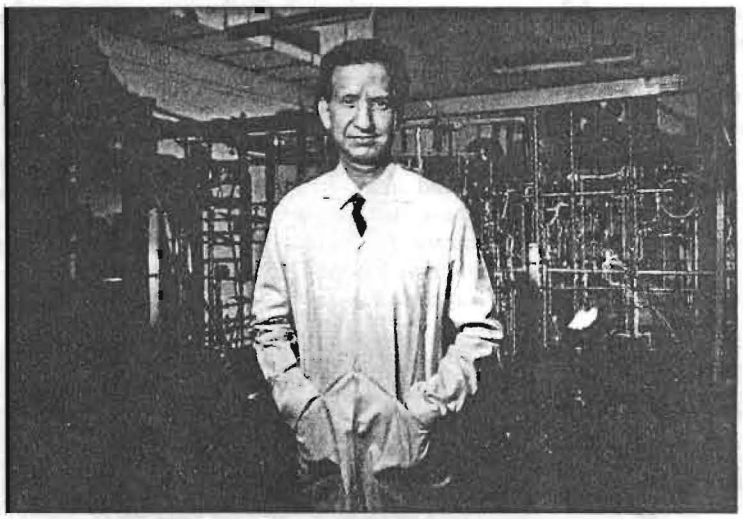
There is a lot of work being done in membrane technology that has led to membranes that can separate oxygen and nitrogen from air without going through liquefaction. For those who wonder how all this hi-tech addresses India's basic problems like providing safe drinking water, the new membrane from NCL that is being tested by Thermax will give virus-free water from the tap — and moreover, at one-fifth the cost of systems based on ultra-violet rays and microfilters now in the market. There are polymers for micro-encapsulation of pesticides that

will biodegrade and lead to the controlled release of the pesticides.

CSIR scientists are being enticed by both Indian and foreign companies with fancy pay packets. But Mashelkar believes that the new steps on monetary incentives coupled with research freedom will help retain talent. The embarrassment of riches, however, creates its own problems. So far, royalty payments have not been significant but if crores of rupees soon start flowing into NCL, the apportionment of the money could generate bad blood between different members of the research group. Mashelkar is very conscious of the problem and is proceeding with caution in setting up procedures and detailed log books for the projects.

Mashelkar is very bullish about internationalising NCL. There are many dimensions to it. Initially he used his reputation as a scientist to get to speak to GE at Schenectady and DuPont at Delaware in the US. Invited for a seminar, he would arouse so much interest on NCL that by the same afternoon the business development people from these corporations started talking to him, followed by senior vice-presidents. These MNC clients for contract research and joint development have been satisfied enough to keep coming back again and again. Recently, at Mashelkar's initiative NCL bought stall space at the ACHME fair in Germany, the most famous trade fair for the global chemical industry, and marketed NCL as a 'global R&D platform'. He was able to excite so much interest over NCL in Kishan Rana, the Indian ambassador in Bonn, that for once an Indian diplomat is actually carrying out the much talked about economic diplomacy. Rana has been meeting various CEOs of German companies to tell them about NCL. Half a dozen German companies have already sent queries to NCL.

But one might ask, as some parliamentarians recently did, why infrastructure built with Indian taxpayers' money should be used to do research for multinationals. Mashelkar eloquently convinced them of the benefits of such research. He points out that while dollars are welcome for a fund-starved CSIR, the more important fall-out is that Indian researchers who can do world-class work also become world class in delivery times, quality and documentation, which will raise the overall level of the country's research. Secondly, he points out that with the massive rise in costs in the chemical industry in North America and the subsequent mass retrenchments, many multinationals are interested in actually transferring the technology developed jointly with NCL back to Indian companies to manufacture these chemicals in India with buy-back arrangements.



Paul Ratnaswamy is India's catalysis man

While receiving the G. D. Birla award for scientific research for 1993 from Prime Minister Narasimha Rao, Mashelkar pointed out that while the government is moving ahead in globalising the Indian economy, it has sadly neglected investing more in science and technology which can make it globally competitive. "We are not afraid of intellectual property rights," he asserts. In fact, he has circulated a well-thought-out note on "Indian S&T in the wake of GATT: concerns, challenges and opportunities". He believes that if we learn to play the patent game properly, we can generate wealth by generating path-breaking ideas leading to new processes and products. But we need not necessarily manufacture these products — we can earn considerable sums of money through royalties by selling patent rights. "Indians have a comparative advantage in intellectual activity, we should fully exploit it," he says.

However, this 51-year-old scientist who comes from extremely humble origins in the working class chawls of Bombay and whose saga of struggle and brilliance is inspiring enough to have been included in Marathi school textbooks, has many other dimensions to his personality. He has headed the commission which investigated the Bhopal disaster and which conclusively ruled out sabotage as proposed by Union Carbide. It demonstrated that poor design of the MIC tank and bad practices led to corrosion of the steel tank, which provided the iron chloride to catalyse an explosive reaction that led to the disaster. He also headed the team that investigated the Nagothane explosion in the Maharashtra Gas Cracker Complex of IPCL. Besides, he was on the scientific advisory group to the Prime Minister during Rajiv Gandhi's tenure and continues to advise the government on a number of issues.

Mashelkar's obsession with globalisation does not limit itself to the economy. In fact, he is a man who does not believe in boundaries. His recent Dankwerts Memorial Lecture in London, the most prestigious lecture in the global chemical engineering circuit, was entitled "Seamless chemical engineering science: the emerging paradigm". The lecture has aroused widespread discussion and enthusiasm in the chemical engineering community the world over. In the lecture, he argued that the boundaries between various scientific and engineering disciplines are vanishing and the more scientists recognise it and use techniques and concepts freely learning from each other, the better science and engineering will develop. In short, Mashelkar was only summing up the basic philosophy that has allowed NCL to become the 'seamless laboratory' it is today.

■ SHIVANAND KANAVI