



Soaring high: Ushering Indian science into the new millennium

The largest chain of public-funded R&D institution in the world has played an important role in the country's socio-economic development, writes **Rajesh Kumar**

# ADDING SCIENCE TO

# LIFE



Incredible as it may seem, the fact remains that the Council of Scientific and Industrial Research (CSIR) pervades all aspects — social, economic and cultural-of human life. From manufacturing baby food (Amul) to bringing out the non-steroid contraceptive (Saheli); from producing life-saving drugs to inventing low-cost building materials; from aiding the Green Revolution to tackling environmental hazards, CSIR has done it all. With 22,000 committed scientific and technical personnel relentlessly racking their brains in 38 laboratories, CSIR has ushered India into a scientific and technological milieu. They continue to work towards improving the quality of life, promoting indigenous and cost-effective technology and prepare the country to face the challenges of the future.

Established in 1942, CSIR had then defined its functions—promotion, guidance and coordination of scientific and industrial research, and setting up laboratories to spur research and development for the growth of industry. Then, the industrial scenario in India was limited to agro-based industries like sugar, oils, jute, iron, and so on, which were largely driven by foreign-based technology. Today, the state of affairs in the science and technology sector has undergone a sea change, and as a consequence, CSIR has grown into one of the largest scientific and industrial research enterprises in the world in the past 60 years. It is also a prime technology source for a majority of Indian industries. Besides, CSIR offers solutions to several problems that are uniquely Indian, and has thus contributed specifically to India's socio-economic transformation.

The very fact that CSIR has been associated with a variety of tasks — from extracting poly-metallic nodules from the entrails of the Indian ocean to flying Light Combat Aircraft in the Indian skies; from defining the genetic configuration of cholera bacterium (*vibrio cholerae*) to providing recipes

for instant gulab jamoon, sambar, idli and dosa—speaks volumes about how the institution touches Indian lives, with regularity.

Providing *swadeshi* solutions to seemingly intractable problems has been the CSIR *mantra*. Its laboratories carry out fundamental and applied research in almost all areas of science and technology. Its objective is clearly to evolve indigenous methods and solutions which can compete with foreign technologies. Says Director General, Dr R A Mashelkar: "Our goal is to achieve foursome objectives of providing industrial competitiveness, social welfare, strong scientific and technological



**Turmeric triumph: CSIR wins the patent war**





**A petroleum refinery unit: Setting new industrial paradigm**

**CSIR has evolved more than 3,000 technologies, with about 6,000 clients using them.**



base for strategic sectors and advancement of fundamental knowledge."

With its vision to provide scientific industrial research and development that maximises economic, societal and environmental benefits to the people, the Council continues to stoke the fire of scientific and technological temperament whose impact can be seen in day-to-day life.

To keep pace with the new world order, Dr Mashelkar, soon after taking over as the Director General, drew up *CSIR2001: Vision & Strategy*—a bold attempt towards evolving a corporate-like R&D and business plan for itself. It was aimed at improving the Council's performance and preparing its labs to cope with the 21st century challenges. Aware of its newer responsibilities in the wake of economic lib-

eralisation and consequent changes in the political, social and technological environment the world over, CSIR reoriented its priorities, redefined its vision and goal, and charted afresh its strategic road map.

The new vision transformed CSIR—the world's largest industrial research and development (R&D) institution—into a client-oriented, performance-driven and





accountable organisation, which was geared to convert its knowledge into wealth and social good through a process of intense innovation. The ultimate recognition of CSIR's ability to successfully manage the change came when the Penguin book entitled *World Class in India* included CSIR amongst the top 12 organisations in post-liberalised India that have best managed radical change-the others being Wipro, Infosys, Reliance, etc.

**S**lowly but consciously, the Council took to greater commercial activities in order to become economically self-reliant as also to shed the slothful image of a government department. The new vision enhanced CSIR's stature in the corporate world, enabling it to enter into alliances with some of India's leading companies like Reliance, Ranbaxy, Godrej and Satyam. The new thrust yielded rich dividends, enabling the Council to earn about 30 per cent of its revenues from contract R&D and services.

While forging strong linkages with the corporate world in India, CSIR forged global partnerships by realising that the chain of concept to commercialisation necessarily crosses transnational boundaries today. The ability to assemble and manage an effective global knowledge network in a short time, rather than developing in-house capability is becoming the key determinant of competitiveness. Taking advantage of this strategic shift, CSIR became a partner of industry around the world today. Mobil &

Indian Institute of Petroleum (IIP) joined hands to develop and market the Mobil/IIP technologies worldwide. Stone & Webster of USA is implementing HP's technologies on vis-breaking. Boeing relies on National Aerospace Laboratory (NAL) for some crucial fatigue research. NAL's software supplied to Civil Aviation Authority in UK determines the landing frequency of aircrafts at Heathrow airport today. National Chemical Laboratory (NCL)'s partnerships with giants such as General Electric, a company with an R&D budget higher than India's R&D budget, was declared as a model for external R&D alliances by General Electric in 1998. Rather than being a perennial seeker of knowledge from the Western world, CSIR is emerging as an exporter of knowledge.

Besides corporate-level global alliances, CSIR has also entered into unusual local partnerships by reaching the unreached in the remote corners of India. Central Leather Research Institute (CLRI) successfully launched Leather Technology Mission, comprising 170 programmes with the help of 60 NGOs, covering 17 states. The Mission is one of the highly successful endeavours of CSIR, which contributed immensely to the growth of the Indian leather sector by reviving 270 closed

**New thrust enabled the Council to earn about 30 per cent of its revenues from contract R&D and services.**

tanneries and saving 250,000 jobs. CLRI has now proposed a *Leather 2010 Vision for India*, going far beyond its technology mandate. It is trying to set the pace for Indian leather industry itself by urging it to raise its ambition and stimulating a bold and visionary thinking.

While winning laurels from the corporate world, CSIR has world's many firsts to its credit, both in scientific research and technology development. Dr Mashelkar says: "CSIR was the first in the world to induce flowering in bamboo. For the first time, Indian science appeared on the front page of *New York Times*! The discovery of seminal plasmin, one of the then smallest protein molecules, has also been a sci-



**Making cures affordable: Some of the drugs developed by CSIR**





**Based on CSIR technologies, the annual industrial production today has risen to about Rs 5,000 crore.**

entific first in the world. CSIR's other prized findings are the discovery of three seamount chains in the central Indian Ocean basin, the marine archaeological discovery of a Harappan age port Dwarka, and an island Bet Dwarka. Also, CSIR was the first to come out with the model which provided an insight into how cracks develop in brittle material."

**W**hile the world was busy mapping the human genome, the CSIR labs demystified the dreaded cholera bacteria, paving the way for the pharmaceutical companies to come out with new vaccines. Even in the field of biotechnology, the CSIR has done wonders. The Centre for Cellular and Molecular Biology, Hyderabad has developed salt tolerant vectors. It made pioneering contributions in understanding the molecular basics of cataract. The DNA finger printing test, which is increasingly being sought today to identify the person involved in certain criminal activities or resolve paternity disputes, is also a CSIR gift to our forensic science.

The CSIR technologies have always stood by Indian industrialists at difficult times. The Director General beams with pride when he says: "Whenever there has been a challenge, we have risen to it. When during the 60s, the developed nations refused to provide technology to the Indian dairy industry on the pretext that spray dried milk cannot be prepared from buffalo milk because it has high fat content, CSIR's Central Food Technological Research Institute rose to the occasion and came out with Amul milk powder. It not only helped the manufacture of baby food but also initiated cost reduction by using the excess fat to produce other dairy products like *ghee* and butter."

Cost-effectiveness is the hallmark of the CSIR technologies. No wonder, CSIR technologies are patronised by majority of small and medium-scale entrepreneurs. Over the years, country's premier R&D organisation has developed more than 3,000 technologies, with about 6,000 clients using them. Based on CSIR technologies, the annual industrial production today has risen to about Rs 5,000 crore. Dr Mashelkar says: "Majority of the Indian industry depends on us for our cost-effective technology which is required to cater to the Indian needs and markets."

The task before CSIR was indeed challenging-providing easy-to-use, indigenous and affordable technology which can cater to a country like India, where 70 per cent of the population live in villages. Committed to the welfare of such a population, the CSIR laboratories evolved technologies for greater productivity and efficiency based on locally available resources and skills. Dr Mashelkar says: "Malaria is a disease of the poor. Would multinationals work on it? No. The reason: they don't want to work on any drug, which yields low profits, and the diseases of the poor certainly do not yield profits." As a result, it is the Central Drug Research

Institute of CSIR, which has developed the anti-malarial drugs, which are not only used in India, but are also being exported to 48 other countries.

Dr Mashelkar, a Fellow of the Royal Society, adds: "We have rich bio-diversity and rich aromatic and medicinal herb reservoir. It's unlikely that foreigners would come to work on our plants and herbs. Obviously, such techniques can't come from abroad. We have ourselves to work on them and create a value. There are needs and problems which are uniquely Indian and for which CSIR alone has developed and can develop technologies." The Goa-based National Institute of Oceanography, another CSIR establishment, showed to the world how a precious metal like manganese could profitably be extracted from poly-metallic nodules - an achievement which gave India the rare distinction of becoming a pioneer under the UN treaty on the Law of the Sea, thus giving her an edge over many advanced countries in the world.

Also, the CSIR



through its R&D efforts at its various labs made rapid advances in the medicine sector and aided cost-effective production of essential drugs such as anti-viral, anti-cancer, anti-glaucoma, anti-bacterials for mass consumption as also off-the-shelf cardiovascular medicines, enabling the Indian pharmaceutical industry to emerge as one of the largest producer of generic drugs in the world. The NCL initiatives made in the 60s led to large-scale production of Vitamin B6, enabling India to turn over a new leaf from an importing nation to exporter of these bulk drugs.

**T**hanks to CSIR's pioneering efforts, AZT, an anti-HIV drug, could be indigenously manufactured in India within a couple of years of its manufacture abroad and that too at a much lower cost. That 12 entirely new drugs of the 15 drugs produced in the sub-continent after Independence owe their genesis to the CSIR is a testament to the country's biggest R&D institution. *Guggulipid*, for instance, is an anti-lipidemic (cholesterol-lowering) drug developed from the Indian medicinal herb, guggul. Its two new drugs—anti-malarial E-mal and anti-asthmatic Asmon made from a combination of indigenous herbs—have caught the imagination of people. This is how CSIR has brought the benefits of science and technology to the common people. More importantly, it brought to the fore relevance of India's traditional medicinal system as also the need for sustained conservation of Indian herbs.

India's problems don't always require high-tech solutions from abroad and probably no one understands this better than the CSIR. Courtesy Central Building Research Institute, today one can dream of building a home of his own on black cotton soil, which due to low permeability and high water-retention had made any stable structure on it virtually impossible. The CSIR affiliate developed low-cost technologies, newer and better building materials

like fly-ash bricks and ceramic tiles as opposed to conventional ones, thus reducing the menace of environmental hazards to a great extent, as also the building cost.

Environmental consciousness and economic urgency have been behind many of CSIR's R&D processes. In fact, National Environmental Engineering Research Institute, another CSIR centre, is engaged in evolving national policies for environmental management. It is also entrusted with air and drinking water quality monitoring surveys in country's major cities.

These studies provide invaluable information on pollution levels and their impact on the health of those living in Indian metropolises. Central Road Research Institute, IIP and National Environmental Engineering Research Institute have recently done pioneering work in providing strong data and analysis on vehicular pollution, which helped in setting up the new Autofuel Policy for the nation.

Chemicals and petrochemicals being the thrust areas, CSIR made major strides in this sector, making India among the top five countries possessing world-class capabilities for formulating new catalysts. Today, many of the CSIR technologies have made their ways to world markets. CSIR developed its own brand of zeolite catalyst called Encilites, which is exported to several countries and used for diverse industrial processes including the production of petrochemicals such as p-xylene, ethyl-benzene and olefins, which in turn are used as raw materials for almost the entire plastic, rubber and dye industries. Also, it has developed



**The 2001 vision transformed CSIR into a client-oriented, performance-driven institution,**



**Creating India's bio-future**



## CSIR—SHOWCASING A TALENT POOL

60-year-old autonomous body  
38 labs, 47 field and extension centres  
22,000-strong work force  
5,500 Scientist and technologists  
R&D infrastructure's present day value US \$ 2 billion  
Annual Budget US \$ 250 million.  
R&D covers all industrial sectors  
Nearly 1000 CSIR technologies commercially exploited  
Industrial production worth US\$ 2 billion per year based on CSIR technologies  
2,000 scientific papers published per year  
500 patents filed per year  
Bilateral scientific collaboration with 30 countries



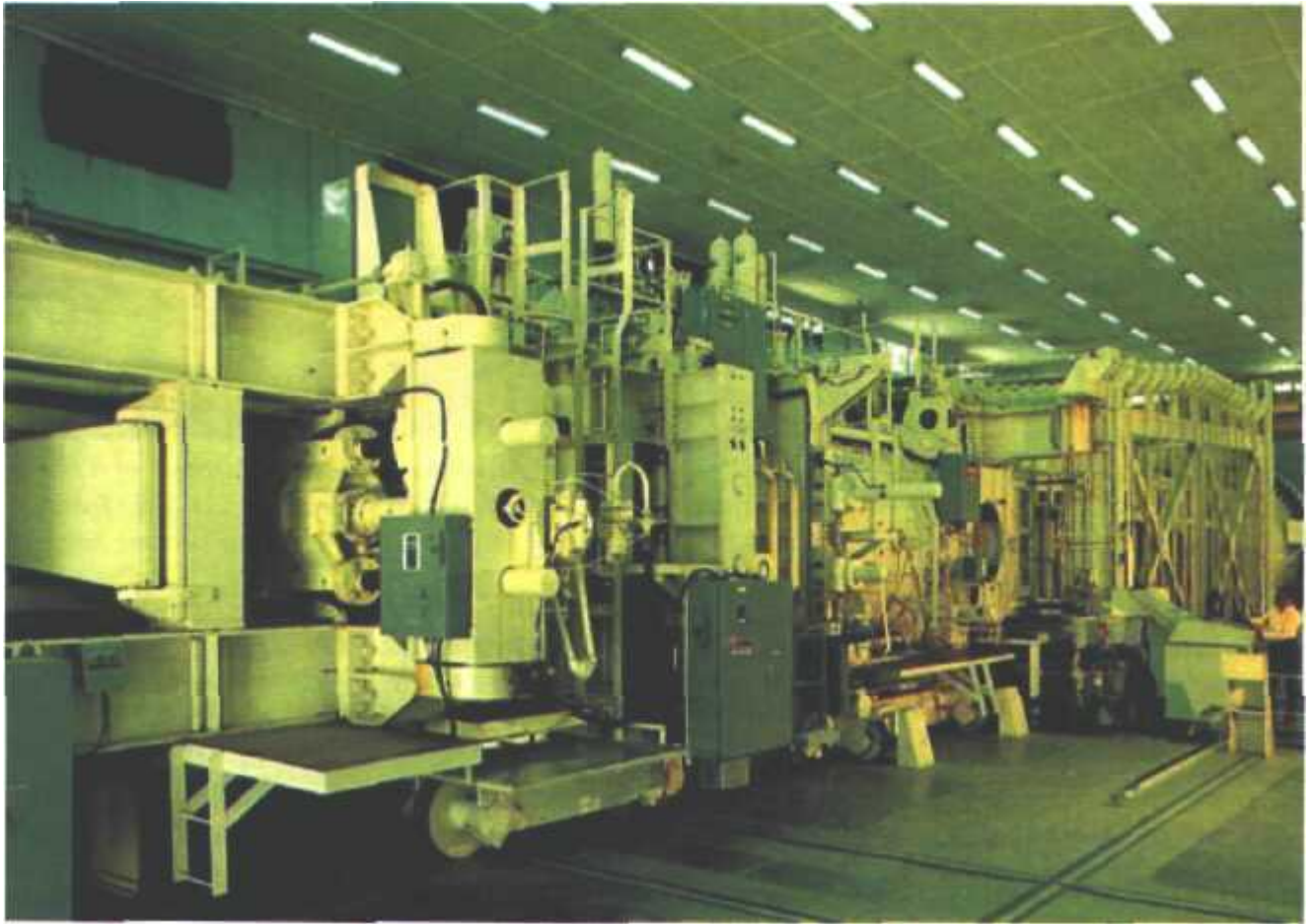
**Poly-metallic nodules: Harnessing natural resources for development**

some neem-based pesticides and is in the process of developing pheromones-based bio-pesticides. Dr Mashelkar adds: "We all talk about Green Revolution but such a revolution would not have taken place without agro-chemicals like insecticides, herbicides, pesticides, etc. How many people know that 70 per cent of agro-chemicals at one point of time produced in India were based on CSIR technologies? So, we helped the Green Revolution in our own humble way."

In fact, CSIR's list of achievements is exhaustive and their impact on Indian society phenomenal. Not only down-to-earth technologies such as developing a wholly indigenous tractor *Swaraj* which spurred the Green Revolution in the country and the one which revolutionised food-processing sector by evolving ready-mixes of 20 Indian recipes, CSIR has made equally significant contributions in high-tech sectors like aeronautics. NAL has not only fabricated Hansa-

**Seventy per cent of agro-chemicals and insecticides produced in India are based on CSIR technology.**





**Trisonic wind tunnel at NAL: (Catalysing aerospace research and development**

3, a two-seater all composite trainer aircraft, and is close to producing Saras, the 14-seater multipurpose aircraft, which will mean the dawn of the Indian civilian aircraft industry but also provided major structural support to the development of Light Combat Aircraft.

**M**ore importantly, the CSIR while pursuing its R&D programme for the country's industrial development, never lost sight of thousands of poor people and a large number of its programme is directed towards rural development.

In the sectors of patent, CSIR has had a remarkable success and today it is the second largest filer of international patents among R&D entities from all developing nations. On the other hand, it fought valiantly to pro-

tect India's traditional knowledge. The turmeric patent is a case in point. Here again, **CSIR** came forward and challenged (1996) the patent given by the American patent office on wound healing by turmeric successfully, and as a result, the US patent was revoked in 1997. "It became history as it sent out signal among the developing countries that other countries can't patent something which belonged to us. It gave us a confidence that nobody can come and appropriate our knowledge. It emboldened the developing world to resist the Western onslaught on their traditional knowledge, ushering a major change in the way international patent classification was hitherto done," says Dr Mashelkar.

These achievements notwithstanding, **Dr Mashelkar** agrees: "Despite 60 years of its existence, **CSIR** is **not a**

household name today. A lot more needs to be done." He adds: "Our achievement has two dimensions—visible and invisible. *Swaraj*, *Saheli* etc are visible sides, but greater part of our contributions remains invisible, such as scientific and industrial R&D which has taken the turnover from small and large-scale industries to Rs 5000 crore as also our enormous contributions in creating India's science and technology manpower." In Science and Technology, sixty years is not a long time and **CSIR** has a long way to go. The 'Team **CSIR**' and 'Team India' spirit that reverberated in the 1998 **CSIR** Director's Conference propels **CSIR** further and deeper in the service of the nation. The Bangalore Declaration—*India matters to us, and it is our endeavour that we shall matter to India more—sums it all.*

## "CSIR pervades all aspects of human life"

*With many laurels already under his belt, the CSIR Director General, who was also named one among the 50 path-breakers in post-Independent India by Business India, is only the third Indian engineer to become a member of the Fellow of Royal Society (FRS) in the 21st century and the only scientist to win the prestigious JRD Tata Corporate Leadership Award reserved for CEOs.*

*He is proud to be associated with an organisation, which helps realise the dreams of a billion Indians. In a freewheeling interview with Rajesh Kumar, he spells out his vision, details CSIR's feats and goes on to say: "If India has the dream to become a major economy, then it has to become smart in handling intellectual property rights." Excerpts:*



**Q. How do you feel to be associated with CSIR?**

A: I am proud that I have completed 25 years of my service to CSIR. It is truly a great feeling to be a part of a family of CSIR, which works relentlessly towards realising the dreams of a billion people.

**Q. Which, according to you, is the single most significant contribution of CSIR?**

A: While celebrating 60 years of CSIR's existence this year, we have identified 60 things that make CSIR proud—be they new products, processes, values, symbols and so on. They include several firsts, several initiatives that have created new jobs or saved existing jobs. CSIR was the first to do reverse transfer of technology in high-tech areas even to the multinationals. It is not easy to enumerate a single most important contribution from that point of view. We can turn the question around and ask, if CSIR did not exist, would India have missed something? I would say, yes, most certainly. CSIR has added enormous value to India by touching diverse aspects in the lives of Indians.

**Q. What is CSIR's USP? Why do a majority of Indian industries depend on CSIR technologies?**

A: Our USP is combining global excellence with local relevance, customer satisfaction and using high science that leads to high technology. CSIR develops technologies that use local resources and fulfil local needs and aspirations. For example, adding value to our own rich biodiversity by creating new products or partnering with our past (that is, traditional knowledge) to create products of the future—like Asmon, a cure for asthma. Such technologies will not be available from abroad. Furthermore to remain competitive, Indian industry needs the latest technology. Such technologies are not available easily. In spite of the Montreal

Protocol, India did not get the technology for CFC substitute. CSIR had to develop it. Finally, multinationals will not work for the diseases of the poor—say malaria. It is the anti-malarial drugs developed by CSIR that Indian companies market today.

**Q. In tune with the new world order, CSIR has begun to redefine its priorities and vision. Will you please elaborate?**

A: In early January 1996, we prepared *CSIR 2001: Vision & Strategy*, a white paper, which was an announcement of CSIR's will to change. We defined a new product and a new process in CSIR—the new product was research as a business and new process was doing research in business-like manner.

We made conscious efforts to ensure that power was not centered in Delhi at the headquarters, it was where the action was. We thus empowered the directors in the laboratories, allowing them greater freedom in decision-making. Autonomy goes with accountability. We built performance-based budgeting systems for our various laboratories.

We set hard quantitative targets for ourselves. It was important to know whether our customers were satisfied and if they would come to us again. We, therefore, set up an independent Customer Satisfaction Evaluation Cell—I believe a first by any Indian public-funded R&D institution.

CSIR believes in progress through partnership at all levels; local, national and global. For this, we had to build strong internal knowledge networks within CSIR, first by building a TEAM CSIR spirit. We launched such major TEAM CSIR efforts in areas, where India can emerge as a global leader.

**Q.** Of late, CSIR has tended to assume greater commercial activities by entering into alliances with some of the world's technology leaders. Why was such a need felt?

**A:** CSIR forged global partnerships by realising that the chain of concept to commercialisation necessarily crosses transnational boundaries today. I personally believe that if you hold hands with the best in the world, you have to run at their pace. Otherwise, you will fall. And in order to become the best in the world, we partner with the best in the world. Working with the technology leaders has helped us in acquiring superior skills in assessing the global technology scene and in improving our R&D management skills.

**Q.** What about CSIR's initiatives in intellectual property rights and traditional knowledge?

**A:** CSIR has brought in the IPR movement in India. In January 1999, our Prime Minister had said during the CSIR Society meeting: "CSIR's winning initiative to challenge the patent on turmeric made every Indian proud. It has also made us aware of the importance of a strong patent regime to both safeguard and promote India's interests in intellectual property".

If India has the dream to become a major economy, then it has to first become smart in handling intellectual property rights. CSIR is showing the way. Within six years our international patent filing has gone up by 10 times. CSIR is the second highest filer of PCT applications amongst the developing countries today. CSIR aggressively protects our own current innovations. On the other hand, CSIR pioneered the concept of Traditional Knowledge Digital Library (TKDL) to protect India's past innovations, at the

not a top down process. The oldest man in the village was taken into confidence, he was convinced that the age-old traditions must change. He blessed what we did. Today, several hundred artisans have been trained by CLRI. This has not only enhanced incomes of the villagers but also changed their perception of science, development and change—in short a micro social transformation. We need to be involved in more such experiments.

**Q.** Why is that despite many firsts to CSIR's credit, it is not a household name today?

**A:** I agree that CSIR is not a household name today. Farmers use *Swaraj* tractor; mothers give *Amul* baby food to their children; doctors prescribe *E-Mal* for patients with cerebral malaria; every year two lakh women in India take *Saheli*, the once-a-week family planning pill—and I can go on and on—but Indians do not know that these are all CSIR products. We need to reach out to people. We have set up an exhibition on 60 things that CSIR is proud of. This exhibition will be taken to all corners of the country. Many will come to know about CSIR and its accomplishments through your publication for the first time! We will be using this diamond jubilee year to reach the heart of India by doing more of this.

**Q.** Let us look to the future, what is the CSIR of your dream?

**A:** My dream of CSIR emanates from my dream of India as a developed country. For this to happen, creative potential of Indians will have to be unleashed. For too long we have talked about the potential of India. I wish to see this latent



**"CSIR of my dream will be an organisation which excels in innovation, compassion and passion."**

same time forcing the international patent system to rethink about modifying the International Patent Classification, so that due respect will be given to the traditional knowledge of the developing world.

**Q.** CSIR has to cater to the rural population. What is the challenge that you see there?

**A:** When it comes to rural population, the biggest challenge before CSIR is—to take care of socio-economic and socio-cultural aspects as well as techno-economics. Let me explain.

A village called Athani is the place where Kolhapuri *chappals* are made. They were, till recently, made by age-old traditional techniques. Our scientists from CLRI studied this and helped to reduce the processing time from 30 to 10 days through application of some good science; the stamping process was standardised; certain innovative changes in design, based on computer-aided techniques, were made to give more comfort to the wearer. But this was

potential energy get converted into creative and productive kinetic energy. CSIR will help India achieve this dream.

CSIR of my dream will be an organisation, which excels in three attributes, namely—innovation, compassion and passion. These three are strongly linked to our anatomy. Innovation emanates from the brain—the mind. Compassion emanates from the heart. The third is passion in the belly. 'I' in CSIR should stand for innovation, not imitation or inhibition. CSIR will be bold, creative and forward looking. Compassion for fellow beings, the poor, the down-trodden will drive CSIR's technology agenda. Finally, CSIR will be an organisation that will work with an unusual passion, in the way it works, it delivers and the way it thinks of India as "my India".

Finally, I have another dream. I very much hope that in 2007, when India celebrates the diamond jubilee of its independence, CSIR will figure in the list of 60 things that India is proud of!