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Relentless 80 Years in the Service of the Nation

Special Contributions

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On Realising CSIR's Amazing Potential

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CSIR and Me

I was born on 1st January 1943. I joined CSIR at its National Chemical Laboratory in Pune on 15th November 1976. I took over as the Director General (DG) of CSIR on 1st July 1995. I retired as DG of CSIR on 31st December 2006. CSIR is the only job that I have done in India for 30 years. I am grateful to the nation for giving me the opportunity to serve CSIR. I have tried to give my best. I hope my best was good enough.

Looking back & looking forward

CSIR has great strengths. They range from its huge diversity of world class competencies to its geographical presence in almost every nook and corner of India. It draws its strength from its confidence emanating from its enviable record of accomplishments, which have been acknowledged by many. For instance, Prof. Jayant Narlikar lists top ten achievements of Indian Science and Technology in the 20th century in his book *Scientific Edge: The Indian Scientist from Vedic to Modern Times* (Penguin, 2003). He lists CSIR transformation in the 1990s as one of the ten achievements. This is a matter of pride.

CSIR is on the march in the 21st century. *CSIR Vision 2030*, launched recently, has the laudable objective of providing innovative Science and Technology solutions with the aspiration of assuming global leadership. It is an extremely inspiring document. It lays down a clear technology roadmap covering short-term, medium-term, and long-term objectives. I fully agree with the ‘why’ and ‘what’ part of it. I would like to add some thoughts on the ‘how’ part of it.



CSIR Vision 2030 released on the occasion of superannuation of Dr Shekhar C. Mande and joining of Dr Rajesh S. Gokhale as Director General, CSIR (Additional Charge). Also seen in the picture Dr Ashutosh Sharma, former DST Secretary

What is this essay about?

This essay is a view from my personal window, lessons learned from the book of my life. So there are frequent references to my own experience in my own journey of 30 years of CSIR, which was followed by 15 years with corporate boards and also global institutions. The essay is all about some strong fundamental principles, attributes and values that CSIR has to imbibe and enhance in order to manage the challenge of change dynamics and create a new CSIR for new India. Nuts and bolts are not discussed here.

“The essay is from one who loves India, adores CSIR but also from one who has given his life for both and wants them to do better to realise their true potential, which is amazingly high.”

The essay is from one who loves India, adores CSIR but also from one, who has given his life for both and wants them to do better to realise their true potential, which is amazingly high.

Creating a STIR in CSIR

What CSIR needs is speed and scale to react to a world that is changing fast not only in nature of doing science, but also in translating it. Also what CSIR needs is a fresh churn and stirring. Churning requires an energetic mixing device. Talent & Technology coupled with Trust can provide a holistic STIR framework for building the CSIR of our dreams. The elements of STIR are the following four.

1. Speed, Scale and Sustainability
2. Talent, Technology and Trust
3. Integration, Innovation & Inclusion
4. Reimagining, Rebuilding and Repositioning

SPEED, SCALE & SUSTAINABILITY

Speed

CSIR can be proud of the fact that when it comes to national crisis, it has responded with great speed. The COVID-19 pandemic is a classic example. CSIR responded speedily by reorienting the scientific manpower in providing quick solutions in various domains such as, Digital and Molecular Surveillance; Rapid and Economical Diagnostics; New Drugs & Repurposing of Drugs; Hospital Assistive Devices and PPEs; and Supply Chain and Logistics Support Systems.

And CSIR has done it consistently in the past. Whether it was providing drinking water, food or shelter during the 1999 cyclone in Orissa, or during the 2001 earthquake in Kutch, or during the 2004 Tsunami that hit us hard, CSIR has always responded rapidly.

But CSIR could do much better if it succeeds in removing bureaucracy by creating enabling, dynamic and positive hassle-free systems. The good news is that the nation’s topmost leadership fully understands the challenge of bureaucracy. The sad news is that things have not changed despite this. Let me illustrate the point.

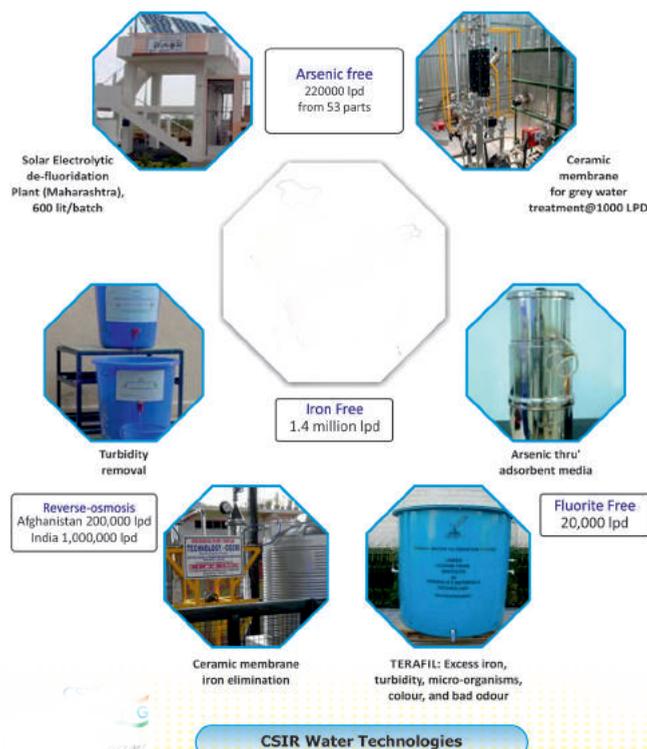
STIR

- Speed, Scale and Sustainability
- Talent, Technology and Trust
- Integration, Innovation & Inclusion
- Reimagining, Rebuilding and Repositioning

CSIR Water Technologies

Domestic Needs

Article 47 of the Constitution of India addresses potable water supply to its citizens. We struggle with meeting this as 66 million are affected by fluoride and 10 million with arsenic and iron contaminated waters. CSIR water technologies address these issues.



On 3rd of January every year, thousands of Indian scientists witness the inauguration of the Indian Science Congress by successive Prime Ministers of India. I have attended most of these and among these, the three that I mention below.

- In 2001, Prime Minister Atal Bihari Vajpayee said, “for Indian science to flourish, the administration and government officials should serve as facilitators of science and not as masters of scientists.”
- In 2010, Prime Minister Man Mohan Singh lamented “it is unfortunately true that red tape, political interference and lack of proper recognition of good work have all contributed to a regression in Indian science.”
- In 2015 Prime Minister Narendra Modi made more specific and pointed suggestions by exactly identifying the pain points while saying "funding proposals must not take too long to clear; meeting application requirement should not become more complex than research; approval process should not become a deterrent for international

conferences and our scientific departments must have flexibility of funding decisions based on the uncertainties inherent in research activities."

Sincere attempts have been made to convert these good intentions into bold action. Efforts to take such actions have been thwarted in the past though. Just as an example, there was a proposal to create a different system for procurement and hiring in industry-sponsored projects in CSIR so that there would be a much faster delivery of results. It was rejected.

“CSIR is not a university, or an IIT or an IISER or an R&D wing of an industry. Its unique space as a translator, facilitator and co-creator in the journey of ‘ideas to impact’ is not clear to many.”

Let alone fast tracking, at the ground level the bureaucracy has increased over the years. Appearing to be right on paper has become more important than being right in practice. For CSIR to become globally competitive, the challenge of removing bureaucracy has to be on the top of the agenda of the government.

Scale

Reaching massive scales can make massive impact. For this, the CSIR technology must not only be ready for commercialisation but also remain sustainable over a large number of years.

How can CSIR move rapidly from TRL 1 to TRL 9? One way is to start by buying technology, which is already at TRL 3 or TRL 4 level or higher from anywhere around the world, and develop it to the commercial TRL9 level in partnership with Indian industry. This model can lead to enormous cost and time saving besides bringing competitiveness. CSIR has not done it in the past. It needs to do it now. CSIR must move up the ladder of TRL through prototyping, pilot planting, market seeding and evaluation, etc.

But as we move up the ladder at higher scales, factors of safety, effluent treatment, round-the-clock running, etc., come into play, which are difficult to attain and maintain in a research laboratory and industry is the right abode for it. We must set up these 'Innovation Translation Facilities' in partnership with industry in industry itself. Further this has to be financially supported and actively facilitated by the Government. Sector-specific clusters will be most effective. Publicly-owned but privately-managed facilities is the way forward. An interesting model that can be fine-tuned to Indian innovation ecosystem is the highly successful Catapult model (<https://catapult.org.uk/wp-content/uploads/2020/12/Catapult-Network-Impact-Brochure-2020-FINAL.pdf>).

Sustainability

A sustainable CSIR also means a CSIR that always remains relevant, robust and resilient, especially in a VUCA world, meaning volatile, uncertain, complex and ambiguous.

It is most important that not only CSIR understands its own distinctive identity but also the other stakeholders, like industry, government, politicians & society understand it. CSIR is not a university, or an IIT or an IISER or an R&D wing of an industry. Its unique space as a translator, facilitator and co-creator in the journey of 'ideas to impact' is not clear to many. The failed attempts to shift CSIR labs to user ministries in the past or misconstrued notions by even some well-known industry leaders that CSIR labs should be placed in industry is a result of this lack of sustained communication about the distinctive standing and big purpose of CSIR.

The Kelkar Committee was formed in 2003 to assess and evaluate the outcome of CSIR activities so far. It was formed by CSIR itself for critical self-evaluation. This report titled *Reinventing the CSIR* clearly brought out the big purpose of CSIR, which was to do public good, private good, strategic good and social good. It also created a quantitative matrix

CSIR should undergo total digital transformation and not just attempt computerisation of some isolated parts of the system in the name of digitalisation. True transformation means a caterpillar changing into butterfly and not becoming a faster caterpillar

(Iyer Nagesh & Vijayalakshmi S., *Research Journal of Applied Sciences, Engineering and Technology*, 2014, 7(15), 3134–3144) to measure the benefit-to-cost ratio and showed how CSIR had always given back to the nation more than the nation invested in CSIR.

Every now and then a question is asked about what CSIR has done. I suggest that every annual report of CSIR should transparently carry this information on return-on-investment by the nation in CSIR by using the Kelkar committee matrix. That will make CSIR strong and sustainable.

Consistent and resilient leadership is an essential prerequisite for sustainability. CSIR has had five acting director generals in the last 15 years, some for extended periods of time. On many occasions, one director has been put in charge of another laboratory for months together. These are completely avoidable delays in appointments.

How can CSIR remain resilient for ever? I have spelt out ten tenets of resilience in my address to the Indian Institute of Corporate Affairs in their *Power Talk Series Lecture* in 2021. These ten tenets include adaptability, agility, resilient thinking, scenario-based planning, digitalisation, platformisation, creating purpose-driven organisation, self-disruption, climate consciousness and autonomous innovation. CSIR should deep dive into each of these in-depth and prepare a strategy for 'Resilient CSIR'.

Take for instance, one of the key tenets, digitalisation. CSIR should undergo total digital transformation and not just attempt computerisation of some isolated parts of the system in the name of digitalisation. True transformation means a caterpillar changing into butterfly and not becoming a faster caterpillar.

Digital transformation should be accompanied by much needed decentralisation of powers to constituent laboratories as also democratisation across the organisation. There must be sense of empowerment and ownership with each of the family member, both scientists as also those in valuable supporting functions.

Digitization, virtualization, mobilization and personalization are the four new megatrends aided by Web3.0 and emergence of Metaverse. All these will lead to game-changing co-creative, self-organizing, self-correcting, asynchronous, dynamic and open systems that will be borderless and globally distributed. CSIR must totally reinvent itself for benefiting from this mega trend.

TALENT, TECHNOLOGY & TRUST

Talent

CSIR cannot be a global leader if it does not have globally competitive talent. Building a strong brand for CSIR is fundamentally as important as setting up processes that will acquire, nurture, continually reskill, inspire and retain that world class talent.

How can we make CSIR competitive today in terms of talent acquisition? CSIR's recruitment processes need to be much faster. There used to be a quick hire scheme for exceptional talent. It is no more there. We need new recruitment processes that bring speed, flexibility and innovation in terms of not just hiring new NextGen talent but also creating access to such talent. Dual appointments with industry and academia and within CSIR labs themselves, new models in human resource mobility within and outside CSIR are some examples of such innovation.

CSIR must endeavour to provide both psychic and physical income to the newly inducted young talent. The psychic income arises from the possibility of challenging work, from possibility of a great career progression path. But equally important is the inspiring and intellectually stimulating environment that each lab of CSIR should provide. In his inspiring Science Congress inaugural speech in 2015, Prime Minister Narendra Modi had said "We want our scientists and researchers to explore the mysteries of science, not of government procedures." Enabling scientists to fully focus on their research rather than on non-scientific and energy-sapping paperwork is critical for creating that psychic income.

Now about the physical income. When I was DG of CSIR during 1995-2006, we introduced monetary incentives for scientists. Scientists got salary from the government but their income had an additional earning based on rewards for their own distinctive contribution to productive industrial research. This incentive has run aground at the moment. It needs to be re-introduced.

The professional progress allowance has been stopped. That needs to be restored. The Lab Reserve, created from the surpluses from external earnings, gave the labs an operational freedom & flexibility. It was meant to be used for development of physical and human capital for the growth of an individual laboratory. So there was an incentive. Now it is being used for recurring expenses like staff salaries, water & electricity bills. The incentive needs to be restored in its original form.

Technology

CSIR should be the powerhouse of frontier technology for India. The limited view of developing indigenous in-house

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Technology Options

- Buy
- Make
- Buy to Make
- Make to Buy
- Make it Together

technology in the laboratories of CSIR from a scratch and then licensing it out to industry is limited to only one option. There are multidimensional possibilities of CSIR contributions to help India build its powerful technology landscape. Let me dwell comprehensively on these.

There are five technology options that I had identified in my C D Deshmukh memorial lecture titled *Economics of Knowledge (Current Science, 77(2), July 1999, 223 – 229)*:

1. Buy
2. Make
3. Buy to Make
4. Make to Buy
5. Make it Together

Let's examine each one of these and see what our new CSIR can do in each one of these.

The 'Make' option: We at CSIR should fully rise to the clarion call by our Prime Minister Narendra Modi on Atmanirbhar Bharat as also his earlier call of ‘Make in India’. However, ‘make in India’ can’t be just ‘assembled’ in India, it has to be ‘invent’ in India and make in India. That means not just producing products but even producing underlying technologies that are made in India. Then only can we create Atmanirbhar Bharat with Atmavishwas.

But we must be realistic that no nation makes everything. Also, if one has to reach a high rate of economic growth, we require the most advanced technology ‘here and now’. Therefore, in some cases, other alternatives have to be sought.

The 'Buy' option: ‘Buying’ technology through foreign technology licensing is the second option. However, some technologies are not available for love or for money. And they are not just in strategic sectors; they are also in civilian sector too. My own experience varies from witnessing denial of access to technology for acrylic acid (used in baby

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diapers) to alpha olefin sulfonates (used in clothes washing) to butyl rubber (used in tyre inner tubes). Further, even when licensing is done, ‘buying’ the core knowledge embedded in a technology or a machinery is possible, only when the owner is willing to part with it.

India is not necessarily being looked at as a bottomless pit of demand by the firms in the developed world. Technology buyers from India are being seen as potential competitors in the world market. Therefore, technology sales are invariably conditioned with marketing territory restrictions. The age of straightforward technology licensing agreements is giving way to technology-cum-market, technology-cum-stakeholding, technology-cum-product swap, etc. Technology is available to a buyer only if it fits in with the supplier’s global scheme.

Again my own experience has been that when Mark III technologies have been developed by the owner, he invariably offers only Mark II and one is finally lucky to get Mark I. How do we deal with this challenge? CSIR can provide a solution.

CSIR must have an active and formal participation with the industry to help it in negotiating the acquisition of the best possible technology based on its deep domain knowledge. I remember my Guru Professor Sharma and me participating in technology selection for public sector petrochemical companies in the 80s, thanks to a visionary Shri Lovraj Kumar, who was then Secretary to Government of India. Helping industry to get the best technology has to be also counted as CSIR’s contribution to technology.

The ‘Buying to make better’ option: Smart countries like Japan opted for the third option of ‘buying to make better’ route. They acquired knowledge through technology licensing (e.g. Sony buying the transistor patents from US), absorbed it and developed superior products, which competed with the best in the world. In recent years, China has taken to this option. Technology absorption strategy was interwoven (explicitly not just implicitly) by China, into its policy right at the time the foreign investor came in. So China would say, ‘we only import once’. India did not do that so well through a strong policy framework. We kept on buying and buying. This needs to change.

The ‘Making to buy better’ option: The fourth option of ‘making to buy better’ means moving up the curve on technology development and positioning oneself at high enough TRL level, if not at commercial level. That positioning itself can create a doubt in the minds of the technology licensor. Cray denied high performance supercomputer technology to India but as soon as higher levels of Param series of supercomputers were unveiled, they offered the technology. After all, strength respects strength.

Deep specialized domain knowledge acquired while oneself doing indigenous technology development leads to a mastery of a technology domain and a clear ability to deep dive into technology options. It then gives one an advantage in negotiations, strategic positioning and so on. It is only then that one can negotiate for Mark III and get Mark III from a position of strength, not just Mark II or Mark I. CSIR can lead such an effort in areas that are critical for India. It has not done it so far. It should do it now.

The ‘Making it together’ option: The fifth option is ‘making it together’, when different actors and stakeholders across the nation come together to build a new technology. This involves public-private partnerships. CSIR has done well here. New Millennium Indian Technology Leadership Initiative (NMITLI) launched by CSIR in the year 2000 is an example. CSIR’s successful post-COVID 19 effort would not have been possible without this ‘making it together’ approach. The newly launched green hydrogen mission by CSIR is a brilliant example of ‘making it together’.

India must have a short, medium and long term plan on what is the dynamic mix that it will create of the five options, namely buy, make, buy to make better, make to buy better, and making it together. CSIR can help India in designing such strategic plans and then partnering in all the five options with all the stakeholders to deliver it.

Startups

India has rapidly moved from a ‘starting-up’ nation to the fastest growing ‘start-up’ nation. It set a new record of producing almost one unicorn (one billion US dollar market cap company) per week in 2021, when 42 unicorns were born that year. Contrast this with one unicorn being born every year in the pre-2019 era.

My own analysis showed that close to 50% of the unicorn start-ups have come from elite institutions like IITs and IIMs and the rest of them from tier 2 or tier 3 cities. That is very satisfying news for India, of real democratisation of innovation.

However, the proportion of deep tech start-ups is very small. The way to build a conducive innovation ecosystem for cutting-edge science-led innovation has been explained in my contribution to a SAC-PM strategy document (<http://www.mashelkar.com/index.php/work/articles/item/377-science-led-innovation>).

CSIR, with its huge scientific prowess, can show the way here. For instance, the Venture Centre at NCL, setup in 2006



is dedicated fully to high-science led start-ups. It won the best national incubator award at the hands of the President in the year 2015 and numerous other honours. With CSIR's amazing geographic reach across India, it can replicate such Venture Centres across the length and breadth of the country.

CSIR as a Technology Leader

CSIR needs to be a leading powerhouse of cutting-edge technology, not only creating the technology itself, but also helping India create an ecosystem through bold public private partnerships to fuel the creation of breakthrough technology. Let's illustrate this with an example.

India recently showcased the first ever invented and made in India hydrogen fuel cell bus using cutting edge technology. This was achieved thanks to a bold and unique Public Private Partnership initiative, namely New Millennium Indian Technology Leadership Initiative (NMITLI) that was launched way back in the year 2000.

NMITLI was bold and unique in many ways. First, it was about leading, and not fast following, in which India prided itself till then. Second, NMITLI took major risks in identifying and funding technologies, where success was uncertain, as these were tomorrow's technologies, and where markets were uncertain too. Third, the funding itself was innovative. The industry got a very low interest loan with very easy payback terms. Fourth, the programme focused on current grand challenges of India and disruptive innovations that could bring in radical yet sustainable transformation.

NMITLI became the largest public private partnership with around 120 plus industry partners and 200 plus public

institutional partners. There were several success stories as also failures since risk taking was a built-in component of the programme.

Trust

I have often said that India's challenge is not budget deficit but trust deficit. That shows up in our daily life in various forms. But it affects many things in institutions such as CSIR, starting with recruitment itself.

I was recruited as Scientist E (Assistant Director position then) based simply on a one-hour interaction (and that's all!) that I had in London in 1974 with the then DG of CSIR, Dr Nayudamma, who came on a mission to do quick hire of exceptional talent by doing away with long bureaucratic procedures. I was then barely a 31-year-old lecturer in a university in UK. My Guru, Professor Sharma became full professor at the age of 27 in Bombay University. No ten-year experience clause for him. Both our appointments were based on trust in our potential by someone, whose judgement was trusted. And both of us justified that trust. We both became recipients of one of the highest scientific honours in the world, namely Fellow of Royal Society (FRS). In fact we are only two out of three Indian residents who have become FRS in engineering science in 360 plus years of the history of the Royal Society!

Need for trust transcends in so many areas. Take start-ups. CSIR cannot become a leader in generating start-ups without backing its talent and technology with trust. It was painful to see the kind of harassments that one of the early start-ups in the CSIR set up by a very eminent scientist had to go

through because of the 'perceived' conflict of interest. Subsequently committees took years to prove that there was nothing wrong!

We have to trust industries with a reputation. We still treat industries (listed public companies) with suspicion, the way we draft agreements, mostly one sided. As soon as I had taken over as DG of CSIR in 1995, I had argued that both Public and Private sector companies act in national interest. Why is it that CSIR scientists are not allowed to be on boards of private sector companies, of course, after weighing the conflict of interest considerations carefully? Our Governing Body approved a process by which scientists in CSIR can be on the Boards of private listed companies. This had immense intangible value for our CSIR scientists, in terms of their understanding the industry's way



India's first ever indigenous hydrogen fuel cell bus developed by CSIR

of strategic thinking and planning, systems and processes, risk assessment, corporate governance, etc.

This provision has gone into a limbo as one sees CSIR being increasingly averse to giving such approvals. Trust must, of course, be accompanied by accountability by those who are trusted. And those violating the trust must be dealt with exemplary punishment.

Let us remind ourselves that when there is no trust at all, paper becomes more important than people. Bureaucracy overrides meritocracy. Guidelines become rulebooks, which become more important than the objectives. Decision making time cycles become longer than the product life cycles.

In summary, for CSIR to become a world class institution, it must balance the trio of Talent, Technology and Trust.

INTEGRATION, INNOVATION & INCLUSION

Integration

Integration has multiple dimensions. The first is the integration of CSIR's purpose with the national purpose, with total alignment. What is good for India is good for CSIR. In CSIR Vision 2030, there is a powerful statement on CSIR alignment with all the national missions, etc. That augurs well.

Second is that CSIR must integrate itself with a diversity of partners – with industry ranging from large to MSMEs, academia, NGOs, start-ups, social entrepreneurs, policy think tanks and so on.

The third is the integration across disciplines. Breakthroughs in research take place at the interface of disciplines. Advances are generally the sum total of numerous creative ideas and interdisciplinary co-operation.

The fourth is the integration within and across national boundaries. Nationally, CSIR has not only created Team CSIR programmes, but also Team India programmes.

CSIR started partnering with leading corporates from around the world, NCL being a pioneer in the early 90s, with its partnership with General Electric, which inspired it to set up the Jack Welch R&D Centre in India, and then others followed. Indeed, seeds of India's emergence as a global R&D platform were sowed by CSIR (Mashelkar, R.A. & Chinchure A., *India Now Business and Economy*, 03(03) Aug-Sep 2016, 28-33).

CSIR also was a pioneer in forging global partnerships in research and innovation. A prime example was taking a leadership position in formation of a global network of CSIR-like institutions, namely Global Research Alliance (GRA), of which I was the President for a decade. In GRA, CSIR-like organisations from the Asia Pacific, Australia, South Africa, Europe and USA had come together to solve global challenges with integrated global science and technology capability for creating global good.

Innovation

Innovation is successful conversion of a new idea into practice. It comprises the journey from mind to market place, from ideas to impact. This journey is rather difficult and over 95% of ideas do not succeed as shown by Burnley and Steven (Greg

A. Stevens & James Burley (1997), "3,000 Raw Ideas = 1 Commercial Success!", *Research-Technology Management*, 40:3, 16-27). CSIR must find a mantra to assure maximum level success in its innovation journey.

I propose a new framework, which, if used proactively, can potentially increase the chance of converting an idea into a business, and then remaining a successful business for a prolonged period. I co-authored a book *From Leapfrogging to Pole-vaulting: Creating the Magic of Radical yet Sustainable Transformation*, in 2018, which won the Tata Literature Live! Business Book Award in the same year (Penguin Random House, Gurugram).

In the book, we emphasised the shift from reactive leapfrogging to proactive pole-vaulting to create rapid, radical and yet sustainable transformation. For assuring successful innovation we proposed using the ASSURED Innovation framework. ASSURED comprises seven important attributes, namely, being Affordable, Scalable, Sustainable, Universal, Rapid, Excellent and Distinctive.

- **Affordable:** An affordable solution creates access for everyone across the economic pyramid. Affordability is achieved by not only creating an affordable product, but also implementing extremely efficient operation, production and distribution systems.
- **Scalable:** Scaling the solution to the largest number of addressable beneficiaries makes the largest impact. In-depth understanding of the market addressability is as important as identification of Blue Ocean (unexplored and vast market place for the offering with the entry barriers).
- **Sustainable:** The solutions have to be environmentally sustainable, economically feasible (with robust business and revenue models), socially acceptable and also adaptable to sudden or radical policy and regulatory



changes. Proactive planning for obsolescence of skills, capabilities and processes by being agile and nimble is important. Good governance is essential for sustainability. PESTEL analysis which focuses on Political, Economic, Social, Technological factors and also includes additional assessment of the Environmental and Legal factors that can impact a business, is fundamentally important.

- **Universal:** Universal means user-friendly, simple and maintenance-free products and services. Standardisation of design, supplies, inputs, processes, customer needs, quality of supplies and resources contribute towards universality.
- **Rapid:** The journey from mind to marketplace has to be rapid, and so is the rapid adaptability to changing market conditions (or even sudden policy or regulatory changes) after entry into the market.
- **Excellent:** The endeavour has to be to use the state-of-the-art technological or novel non-technological solutions. But, that is not enough. We need business excellence, including leadership, strategy, customer focus, information management, people and processes.
- **Distinctive:** There is no use creating 'me too' products and services. Solutions must be protected by robust intellectual property portfolio raising entry barriers for the competitors.

In the book, we have done an analysis of several technologies and businesses, which met the ASSURED criteria at one time, but failed later because they failed some part of the ASSURED criteria.

Three important points about the factors in the ASSURED framework. First, all the seven factors are dependent on each other. Better A (affordability) can lead to bigger S (scalability). Second, since the factors within ASSURED are time variant, once ASSURED does not mean always ASSURED. Third, either fully quantitative, semi quantitative or qualitative value can be attached to all the seven factors. Weightage given to each factor depends upon the type of business.

I was the chairman of the standing committee on selection of the best in class technologies for drinking water and sanitation created by the Department of Drinking Water and Sanitation during 2004-19. I am proud to say that NEERI of CSIR created an outstanding ASSURED framework, which has been institutionalised by the ministry for selection of technologies today. I have separately discussed how this framework is being used globally now for diverse applications (Mashelkar, R.A., CII STRIDE, *Journal of Technology Leadership and Innovation*, 01(01), Dec 2021, 17-24).

The productivity, efficiency and success rate of CSIR innovations can go up dramatically if CSIR uses ASSURED matrix for project selection, funding, monitoring, delivering and also keeping track of post-delivery performance in Industry. This will create a new CSIR, whose outcome will not be just the amount of license fee that it earned from industry but the continued profitability of the licensee industry.

Inclusion

India needs accelerated inclusive growth, where no Indian is left behind. Inclusive innovation can act as an inspiring accelerator. The need for this is even more urgent today. Why?

India reduced the number of poor people from 340 million in 2011 to 78 million in 2019. This number was expected to decline further to 59 million in 2020 but ended up increasing to 134 million. This represents the biggest reversal in India's fight against extreme poverty (<https://ceda.ashoka.edu.in/covid-19-setback-the-strongest-reversal-in-indias-battle-against-extreme-poverty/>).

CSIR has had a rich history of inclusive innovation. High quality affordable generic drugs for the whole world based on CSIR technologies, is just one powerful example. Most recent is the Aroma mission which has been a huge success. CSIR 800 was a model programme on inclusive innovation.

CSIR should be a global leader in inclusive innovation that creates the world's most affordable products and services with the highest quality. That will certainly create the magic of access equality despite income inequality and bring social harmony in the world.

REINVENTING, REPOSITIONING AND REBUILDING

The new India will need a new CSIR. And therefore, CSIR must continuously reimagine, rebuild and reposition itself so that it always remains relevant to India. We have done that regularly.

- In 1996, we had 'CSIR 2001: Vision and Strategy'.
- In 2011, we had 'CSIR@80: Vision and Strategy 2022'.
- In 2022, we had 'CSIR Vision 2030'.

Each of these has played a key role in direction setting for CSIR in the emerging context.

CSIR can rise to its true potential, if full autonomy is given to it. CSIR is registered under the Societies Registration Act 1860 as an autonomous body. It has hardly functioned, however, as a fully autonomous body. CSIR should be provided full autonomy on the pattern of the Department of Atomic Energy (DAE) and Department of Space (DoS). Using this model, a Scientific & Industrial Research Commission should be created, with an eminent scientist/technocrat becoming the Chairman of the Commission.

In times to come, CSIR has to show the way to the nation, and provide leadership.

There have been instances when CSIR has shown the way. Whether it was the first creation of buffalo milk leading to Amul baby food, the first once-a-week oral contraceptive non-steroidal pill Saheli, the first drug EMAL for resistant malaria, first institution to introduce DNA fingerprinting in India, first to create a Traditional Knowledge Digital Library (TKDL), which prevented unethical exploitation of Indian traditional knowledge, first to convert India from an industrial catalyst importing country to an exporting country. And the list goes on.

My Dream...a CSIR...

- that does research that creates new markets, not only in India but in the world.
- that creates and leads new missions just as it did in the leather technology mission.
- that does game-changing disruptive innovation to create radical yet sustainable transformation.
- that creates technologies that are first in the world.
- that creates next practices that others will follow as their best practices.
- that does not leapfrog but pole- vaults to new unimaginable heights and distances.

CSIR has not just been a leader in technology but also a thought leader, action leader, trend setter and a game changer too. The challenge has been maintaining that leadership. Let me illustrate it with just two examples.

CSIR brought patenting culture to India with the slogan of 'patent, publish and prosper'. CSIR was the top leader in the number of US patents granted to India for years together. In 2003, CSIR topped the WIPO published list of prestigious Patents Cooperation Treaty filings in Asia. CSIR was ahead of the leading South Korean companies like LG and Samsung with Huawei from China being in the fourth place. The same Huawei became the top filers of patents among all the industrial enterprises in the world in 2019. We are not amongst the top anymore.

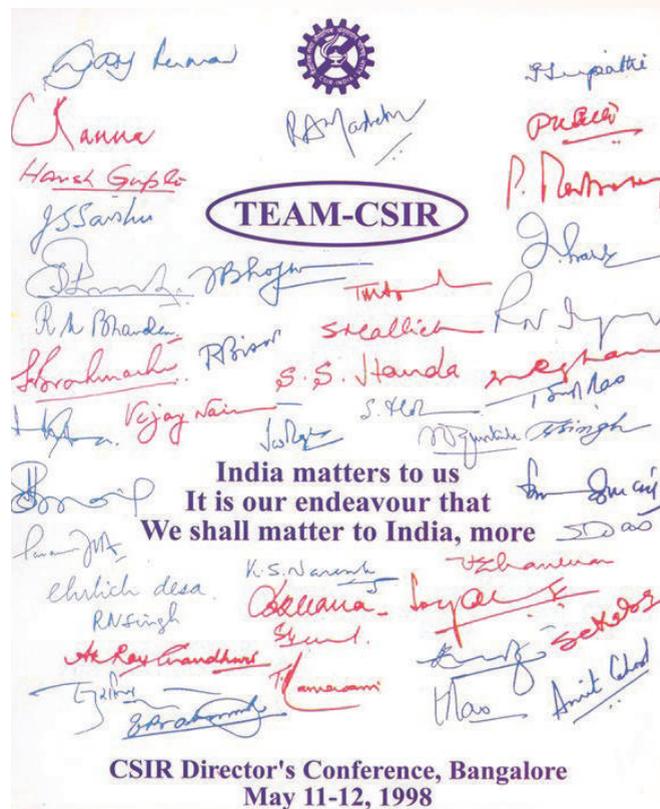
Yet another was Open Source Drug Discovery (OSDD), which was a pioneering CSIR-led team India consortium with a vision to provide affordable healthcare to the developing world by providing a global open platform. OSDD brought together the power of genomics, computational technologies and participation of young and brilliant talent from Universities and industrial partners. It had over 7900 participants from 130 countries across the world. It set waves around the world but due to several reasons it lost momentum in India.

CSIR has demonstrated its capability to lead but not consistently. The challenge is to make global leadership a way of life and not just a flash in the pan. New CSIR should have the potential to do it.

MY DREAM OF CSIR

The CSIR of my dream is one that just doesn't do market-driven research but does research that creates new markets, not only in India but in the world.

- A CSIR that just does not help the national missions but creates and leads new missions just as it did in the leather technology mission.
- A CSIR that just does not do incremental innovation but game-changing disruptive innovation that helps in creating a radical yet sustainable transformation.



- A CSIR that creates technologies that are not just first to India but first to the world.
- A CSIR that just does not follow the best practices of others but creates next practices that others will follow as their best practices.
- A CSIR that just does not leapfrog but pole- vaults to new unimaginable heights and distances.

FINAL WORDS

One might ask as to what is the most memorable day of my life in CSIR. Well there have been many in this long career, but if I were to go for just one day, it will be 11 May 1998.

On 11 May 1998, we had a CSIR Directors' conference in Bangalore, the entire family of 40 directors of CSIR was present. At the end of the meeting, there was an amazing spontaneous gesture by CSIR Directors. All the 40 Directors signed the Bangalore Declaration. They said 'India matters to us. We want to matter to India, more.' And the headline of the declaration was Team CSIR.

This Team CSIR spirit was spontaneous, it was sincere, it came from the heart of everyone. And it is this Team CSIR spirit that will catapult it to great heights. It is this Team CSIR that should integrate itself deeply and indeed inspire the creation of a New India of our dreams, a nation that will do us proud by assuming its rightful position at the top of the comity of nations.

