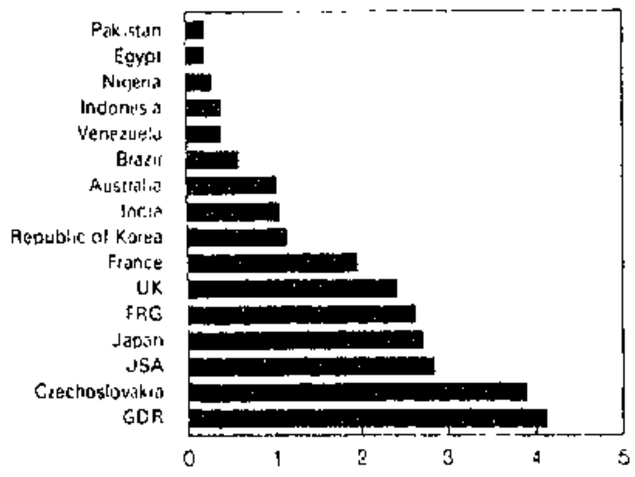

Figure 7. R&D expenditure as percentage of GNP for selected countries.

Table 2. Summary of recommendations to give scientific agencies more flexibility.

Scientific departments must introduce zero-base budgeting
They should be empowered to create posts
Flexible complementing scheme to be adopted while promoting scientists
Exemption from purchase through DGS&D
Exemption from scrutiny by Staff Inspection Unit
Scientific departments (with major civil works) could have their own civil engineering wings
Autonomous bodies like ICAR, CSIR, etc. to have full financial powers without reference to the concerned ministry

While expenditure on S&T rose over the years, as did the scope of the R&D activity, the system itself was not concurrently streamlined to handle this increased activity. Subsequently, based on a recommendation of the Science Advisory Committee to the Cabinet (SACC), a series of decisions were taken to enable the science agencies to function better (see Table 2). Chaturvedi was of the view that, despite these delegations, there has not been a matching improvement in performance. On the other hand, it also emerged during the discussions following Chaturvedi's presentation that many government departments are *yet* to implement the decisions, although presidential sanction for the same was accorded *six* years ago!

Chaturvedi concluded his presentation with a series of questions relating to funding and the administration of science, all of which need consideration. The most important of these was: Where greater autonomy has been given, has there been a corresponding increase in accountability?

Zero-base budgeting—a primer

In December 1983, Government accepted in principle the recommendation of the Science Advisory Committee to the cabinet that the budgets of all S&T departments be formulated on the principle of zero budgeting. Subsequently, a committee headed by T. N. Seshan prepared a full report on the introduction of zero-base budgeting by S&T departments/agencies. An extract from the report to highlight what exactly is meant by zero-base budgeting:

The principle of zero-base budgeting (ZBB) is the following:
(i) Start from 'base zero' every year.
(ii) Look at every activity afresh.
(iii) For each identifiable activity (called decision package in ZBB terminology) find the most cost-effective way of execution, and feasible activity levels and corresponding resources.
(iv) Rank each decision package based on a set of criteria (priority allocation).
(v) Draw the line of acceptance based on the total resources available.
(vi) Iterate the above with work-around plans in case the resources fall short of requirements.
(vii) Plan and budget from alternative sources of funds to promote and protect the programme's objects and priorities.

The focus is on the programme and total resource requirements for the cost-effective option. The inevitable budget cuts can be absorbed rationally, instead of arbitrarily, without necessity of recycling the entire budget exercise. Real-time reallocations or reappropriation between the approved programmes can be done more rationally in the event a programme is unable to realize expenditure as planned during the financial year due to unforeseen technomanagerial or procedural or external reasons.

Auditing science—the Indian situation

S. Sathyamoorthy has, at various times, written extensively on performance in the S&T front and the problems faced. Since his views are of both interest and importance, various extracts are reproduced below. These also are taken from the background material supplied at the Delhi meet. We start with a question posed by Sathyamoorthy which is also uppermost on many minds.

Has Indian science struck roots? Have the results and achievements touched the lives of the common man? In the words of [former primer minister] Rajiv Gandhi:

Development and science are related. Underdevelopment by definition is the lack of being able to use modern science and technology

To promote the cultivation of science . . .

In 1958, the Government adopted a 'Scientific Policy Resolution', which was supposed to provide guidelines for the growth of science and technology in the country. Later, in 1983, the Government made a 'Technology Policy Statement', which was a kind of sequel to the earlier resolution. Given below are some extracts from these two documents.

First, some extracts from the 'Scientific Policy Resolution':

The dominating feature of the contemporary world is the intense cultivation of science on a large scale, and its application to meet the country's requirements.

The Government of India have accordingly decided that the aims of their scientific policy will be

(i) to foster, promote, and sustain, by all appropriate means, the cultivation of science and scientific research in all its aspects—pure, applied, and educational;
(ii) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation;
(iii) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;
(iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;
(v) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom; and
(vi) in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Government of India have decided to pursue and accomplish these aims by offering good conditions of service to scientists and according them an honoured position, by associating scientists with the formulation of policies, and by taking such other measures as may be deemed necessary from time to time.

Extracts from the 'Technology Policy Statement' made by the Government in January 1983:

The basic objectives of the Technology Policy will be to

(a) attain technological competence and self-reliance,
(b) provide the maximum gainful and satisfying employment to all strata of society,
(c) use traditional skills and capabilities,
(d) develop technologies which are internationally competitive,
(e) reduce demands on energy,
(f) ensure harmony with the environment, preserve the ecological balance and improve the quality of the habitat, and
(g) recycle waste material.

for the benefit of our people to increase their productivity, to increase their comforts, to improve their life-span. If we are going to break this barrier, it must come from our scientific institutions and from our scientists, technologists and industrialists.

Viewed in the light of these objectives, Indian S&T has yet to produce effective contraceptives, cheaper building materials, dependable communication systems, the much-needed vaccines, industrial materials, etc.; or, seemingly moving from the sublime to the absurd, we are yet to produce non-leaking taps, lasting shoestrings and well-sticking glue.

The National Research Development Corporation, a Government of India undertaking, has been assigned the responsibility of promoting indigenous technologies and inventions. Almost 75% of processes referred to it originate from CSIR laboratories, about 9% from Defence establishments, about 2% from the Railways and the rest from other sources. Data regarding the number of agreements signed by it, new processes that have gone into production, etc. are given in the table.

The gross royalty and premia earned by NRDC, which was Rs. 10.5 million in 1982–83, increased to Rs. 10.6 million in

Technology transfer by NRDC during 1980–1985.

Year	No. of licence agreements	No. of new processes put into production	Estimated investment by entrepreneurs (Rs. millions)	Estimated value of production (Rs. millions)
1980–81	119	10	13.5	1
1981–82	127	8	3	0.4
1982–83	120	11	95	10.3
1983–84	136	5	4.5	0.4
1984–85	138	4	13	2

1983–84, but registered a marginal decline in 1984–85. Thus the return on R&D has not made any appreciable increase, although allocations for S&T have gone up substantially.

What are the reasons for the above state of affairs? Perhaps absence of effective management.

Echoing these concerns, the prime minister, in a conference of directors of national laboratories, observed:

> This really means that what we are looking for is much better scientific administration. Scientific administration must be a subject on its own. It cannot be borrowed from our general bureaucratic system. At the same time, the answer is not to find the best scientist and make him an administrator because then we lose a scientist. Perhaps we do not even gain in administration. It is a very specialized task. We have not developed in this area and we must see how we can develop this.

As is only to be expected, Sathyamoorthy himself wonders why an administrative structure suitable for the growth of S&T has not been evolved. He continues:

Why have we failed to develop science administration? To begin with, there was the heady cocktail of mixing the preservative spirit of governmental culture with the innovative spirit of scientific culture. While innovative spirit had to be nurtured and promoted, it also had to be recognized that creativity did not last for a lifetime. Necessarily, therefore, scientific ideas, institutions and personnel had to be constantly turned over. However, this has not happened in Indian science, and the Abid Hussain Committee tellingly detailed this aspect [see box for more extracts]:

> Scientists wanted the best of both the worlds. . . they wanted flexible complementing, liberalizations, generous funding, as well as security of job for a lifetime. This heady cocktail is unscientific, unhealthy and is eating into [our] vitals.

Secondly, scientific bodies have proliferated without direction.

Yet another area of failure was the innovation chain not stretching up to the realization of industrial products. For this purpose, an organic relationship between the research institution and the user institution was necessary. However, audit has come across instances where such organic relationship could not be established even between two govern-

The failures of CSIR

CSIR has a big chain of national laboratories, dispersed all over the country. Its activities and performance have been the subject of frequent comments, both in the press and in Parliament. In order to have flexibility, CSIR formed itself into a registered society and yet, by adopting the standard government practices lock, stock and barrel, it lost a golden opportunity to evolve its own rules.

In 1986, Abid Hussain (then of the Planning Commission), submitted to the Government a report on CSIR, in which he examined its performance. The report generated an intense debate. In the present context of science and public accountability, it seems pertinent to publish a few extracts from that report.

Starting with expectations and performance, Hussain remarks:

The CSIR system has not lived up to expectations. It has not provided much in terms of scientific breakthroughs or advances in the frontiers of knowledge which have received international recognition. It has been unable to develop technologies which would meet even the most agonizing needs of our economy and society, let alone facilitate modernization.

There is no clear sense of direction. The major failure, perhaps, is its inability to transform scientific results in the laboratory into technologies for industrial production.

According to Hussain there are many reasons for this failure, one of which is that

there is disproportionate emphasis on basic research, not always well chosen, which can bring recognition from other scientists in the profession; as a corollary, applied research in the sphere of development of technology is mostly neglected, *inter alia*, because it is riskier and yields little in the form of academic kudos and material rewards. Even in the realm of basic research, however, international standards of excellence have been attained only in exceptional cases.

Hussain would like CSIR to have a clear sense of direction and a clarity in objectives. Towards this end, he offers many suggestions. He also has things to say about CSIR headquarters. He remarks:

At present, the functions of CSIR headquarters are largely administrative rather than scientific, which is not as it should be. We believe that the headquarters should be the nerve-centre of the CSIR system and not its administrative muscle. Its principal task should be to plan for scientific research and technology development, for which purpose it needs more horizontal liaison outside CSIR and less vertical control within CSIR.

Finally, he emphasizes that 'CSIR should function as a society and not like a department of the Government'.

ment departments, and the money spent on research projects was rendered meaningless.

Indian science has also spread its resources thin. We may not have life-saving drugs or much-needed vaccines, but we have research programmes on desert medicine, Himalayan medicine, folk medicine, traditional medicine, sports medicine, Vedic medicine, nuclear medicine and what have you. Such spreading is a direct result of growing vertical empires built to accommodate personnel!

Having described many of the shortcomings of the scientific establishments, Sathyamoorthy also talks about science audit, its role, some of its findings.

Measurement and analysis are fundamental to science, yet measurement of performance and analysis of reasons for failures seem to be anathema to scientists. A simple example is absence of project accounting in science, be it a laboratory project or a capital-intensive project. Unless individual project accounts are kept, how can we ensure that there is no inefficiency or wastage in terms of time and money? But this is never done and accounting is gross. Science Audit has come across cases where land is bought, equipment acquired, and even buildings constructed with money from revenue account because capital account is closed!

Scientists' viewpoint is that research cannot be planned, or made to order; research should be left alone to the researcher; research results cannot be predetermined; and in the final analysis it is the creative, innovative individual who generates new knowledge and he should not be bound by auditorial and bureaucratic chains. In other words, they say, 'Provide money to scientists; ask no questions, and take what comes.' They desire immunity from accountability. But it is not for constitutional requirements alone that project accounting is required; it is also required for scientists to measure their performance in terms of time and money spent and to analyse their mistakes.

Science Audit is not engaged in fault-finding; it is engaged in fact-finding. It endeavours to find out whether the department or laboratory has drawn up suitable systems before embarking on ambitious projects. Secondly, audit wants to ensure that the personnel who have to operate the systems act in a bona fide and cost-effective manner. This is ensured by checking whether the scientific efforts have been carried out within the parameters drawn up by the scientists/laboratories/departments themselves. The parameters relate to cost, time and physical resources. If there is escalation in cost or failure in time schedule there should be reasons. After all the parameters had been drawn up by the departments/laboratories, keeping in view the constraints of the environment in which they operate. In other words, Science Audit measures performance against self-designed parameters. The effort is to have achievement accounting of the scientists and laboratories.

Commenting on the problems scientists have with administration, Sathyamoortky observes:

While, on the one hand, scientists reject traditional administrators because they cannot respond to the needs of science today, we find scientists themselves making poor administrators. Perhaps what we require is a mutant of the present-day administrator.

According to Sathyamoorthy, instead of effective management, scientists and scientific establishments have been gravitating towards soft administration. Elaborating, he says:

Scientists asked for autonomy and CSIR was an example. Later they asked for independence and the Department of Atomic Energy became the example. Further on they asked for liberalization and freedom from controls and we did away with DGS&D, DGTD, UPSC, foreign exchange control, etc. Ultimately, they are the final decision-makers for science policy and plans, with a member (science) in the Planning Commission. And with most of the scientific ministries/departments under the prime minister, even political control over science has become diluted—because, had these been distributed under various ministers, the prime minister could have questioned their performance. With so many liberalizations, autonomy, freedom from controls, and centralization of decision-making, the only control over Indian science that still survives is the indirect control of audit!

A unified Science Audit was created in April 1986 to audit departments like DAE, DOS, etc. Explaining these developments, Sathyamoorthy remarks:

Since the Comptroller and Auditor-General (CAG) has been given the responsibility of protecting the interests of the common man, the constitution and the citizen rely upon the CAG's judgement, dedication and professionalism in ensuring accountability of scientists. I may quote here my Audit Officer B. K. Das, who says:

Scientists and auditors are both truth-seekers.
Both analyse, investigate and even dig deeper
To unearth facts—being the nation's trust-keepers,
Their inaction would make the nation weaker.

The findings of Sathyamoorthy made headline news some time ago. Not all in the S&T establishment were happy with his critical observations. Reacting to this, Sathyamoorthy says:

Commenting upon Science Audit findings, Bal Phondke, erstwhile editor of *The Economic Times*, observed:

The scientists are apt to get carried away by their own accomplishments so that a realistic estimate of their potential and worth or the investments in time, personnel as well as finances needed to bring them to fruition is not possible.

Sathyamoorthy is keen to assure the scientific community that he is not their adversary. He adds:

I am all for science and I am aware that the country can exist without audit but cannot exist without science. But it is this very criticality of science which underscores the need for an able performance by scientists. If today's scientists, administrators, policy formulators, managers, auditors, planners and ministers do not exercise vigilance, our scarce resources may be misapplied, our rate of growth may become slow. This we can ill afford. I cannot put it better than what Prof. Blackett has said:

We must endow ability whenever it is found and we must guard against subsidizing mediocrity.