mediocre, who, lacking commitment to progress, often keep themselves busy by devising ingenious ways of beating the system and bleeding it. As Bhargava pointed out, wastage and shady operations are quite widespread. The establishment's answer to this has always been to impose more controls and checks. In all this, it is the person with drive and talent who suffers. No matter what one's professional reputation and credentials, one is treated on par with all the rest and slowed down in the process. And so the cry goes round that Indian scientists are no good and are non-performers. One finance man vitriolically remarked during the meeting, 'Our scientists are not Michelangelos, and mediocre scientists will get only mediocre treatment.'

No amount of articulation seems to convince our establishment that it is not Indian scientists who are wanting but our system. Writing recently in *The Hindu* (25 May 1990), P. V. Indiresan, a former director of IIT, Madras, observed: '. . . in a recent nationwide selection of the most outstanding hundred or so young engineers in the entire US, ten per cent of the places went to Indians—nearly ten times the national average. This is the kind of talent we have lost. . . . tears of inconsolable sorrow are shed when the flower of a nation's youth is lost in war. . . . Yet when it comes to top technical talent, the only desire our society has is for them to forsake our country and settle abroad, actually compete against us and work to diminish our prosperity.'

Notwithstanding the loss of talent, there is still quite a bit of it left here but unable to give off its best thanks to the shackles imposed. Add to this the overall poor work culture, the plethora of holidays, etc., and non-performance is all that one can expect.

Our system is so complex that when I deal with a finance man I am expected to be up to his level of understanding on matters financial, when I deal with a contracts man I should know enough on legal matters to answer his queries and objections, and so on. Nobody bothers that all this cultivation of unrequired expertise leads to dilution of technical talent. The scientist and the engineer must be *allowed* to perform, and *enabled* to perform *in the area of his or her chosen profession* instead of being obstructed, as, sad to say, happens most of the time. Perhaps our institutes of management should give serious thought to how our S&T should be managed and then train the required managers so that scientists become free to do what they can do best.

I once had a long and anguished talk with a very senior bureaucrat who is quite knowledgeable. He felt that scientists should not complain but must be ready to sacrifice in the Indian tradition. 'Think of Ramanujan', I was told. Is this being realistic?

I would be unfair if I were to lay the blame entirely on the establishment since scientists too have their own share to carry. For one thing, scientists turned bureaucrats are often more obscurantist than honest-to-goodness bureaucrats themselves. Secondly, there are serious lapses of concentration on the part of many senior scientists who have earned such epithets as non-resident director, director-at-large, etc. There really does not seem to be a pressing need for travelling so much and getting involved in the business of other bodies, organizations and institutes, when one's own home is not in order. Then there are the endless conferences, workshops and what have you, complete with bags and company-sponsored lunches/dinners. Finally there is the talented minority at the fringe, young and dynamic no doubt, but somewhat uncommitted to our institutions, like our journals, for example. 'We cannot publish in them until they attain world standard and achieve wide circulation', they say. Sounds reasonable no doubt, but who is to achieve all this? Some Maxwell's demon?

Altogether it seems to be a painful chicken-and-egg problem. The scientists say: 'The system is dreadful. Streamline it first and give autonomy before demanding performance.' (Science Audit believes there is already too much autonomy.) The establishment retorts, 'No way', citing horror stories. 'What we need', they say, 'is more accountability.'

And so it is all boiling down to accountability without true responsibility, flexibility and adequate freedom to operate. I am afraid this is not going to work, and we have seen this already. Maybe we should be prepared for endless rounds of 'exposures' and 'raps' by the auditors and perhaps also for more meetings (like the one reported) searching for the missing accountability. We have yet to learn that responsibility and accountability go together, and that we cannot have, as at present, two groups, one enjoying power without responsibility and the other saddled with responsibility but not given the enabling powers.

I know a very bright person who had studied physics in college and was therefore reasonably knowledgeable about what science is. Later he joined the Indian Administrative Service. While in service he was a hard man to please, as I learnt from experience! Subsequently he took voluntary retirement in order to enter business, and promptly was up against bureaucratic hurdles like those he himself used to place earlier. Once out of Government he became wiser. I met him after his retirement and we exchanged tales of woe. I then asked him, 'Will things ever change?' He thought intensely for a minute and replied, 'Not for at least a hundred years.'

G. Venkataraman is Director, Advanced Numerical Research and Analysis Group (ANURAG), DRDO, P. O. Kanchanbagh, Hyderabad 500 258.

India's S&T budget

B. K. Chaturvedi, Joint Secretary (Finance) of DST, offered at the Delhi meeting a bird's-eye view of the manner in which investments in S&T have grown over the years. His presentation, which was rich with statistical information, is summarized below.

In absolute terms, expenditure on S&T has grown from less than a billion rupees two decades ago to more than twenty-five billion rupees now (see Figure 1). The growth in expenditure as a percentage of GNP can be seen in Figure 2. Most of the money for R&D

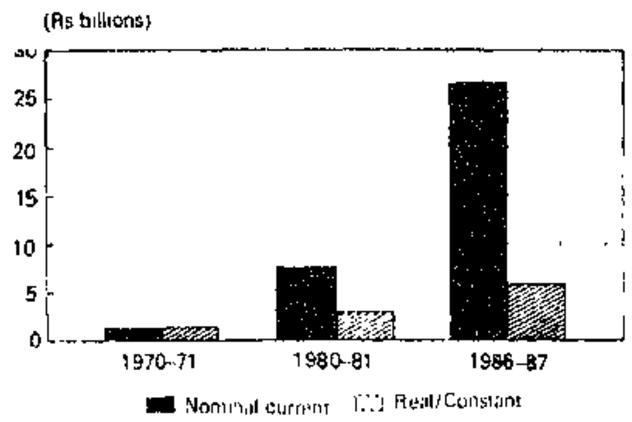

Figure 1. Expenditure on R&D in nominal and real terms.

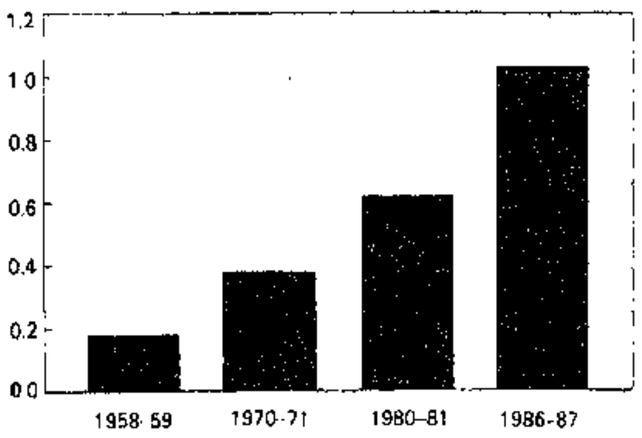

Figure 2. National expenditure on R&D as percentage of GNP.

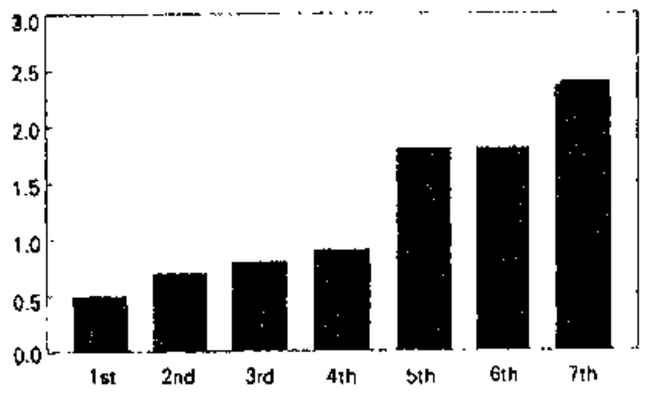

Figure 3. Plan allocation for S&T as percentage of public sector outlay.

comes from the Government, the private sector contributing a negligible amount. It is not merely the amount, but even the percentage of plan allocation for S&T has grown over the years, as Figure 3 shows. Of course, on account of

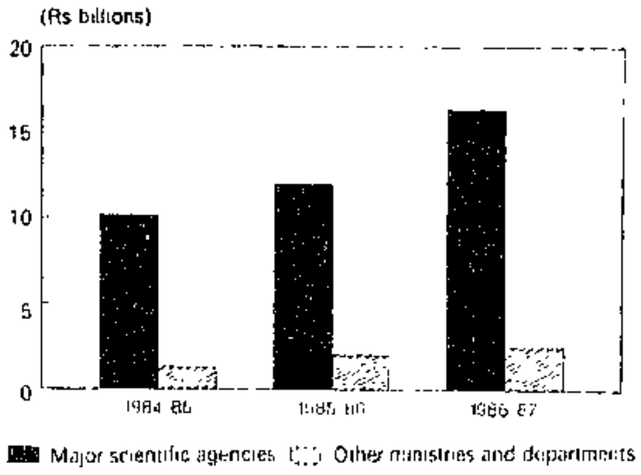

Figure 4. Share of R&D expenditure by major scientific agencies and other departments.

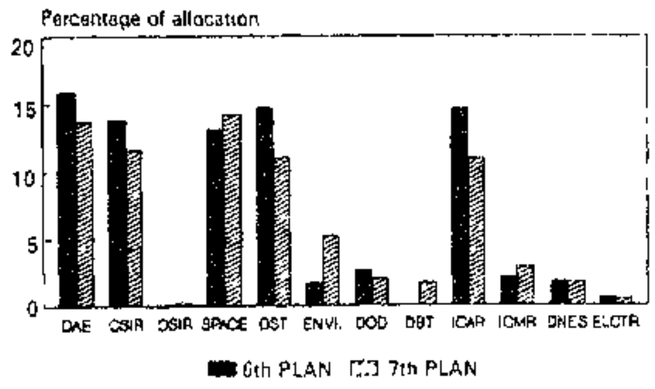

Figure 5. S&T allocation (Plan+non-Plan) for scientific agencies.

inflation, the real growth in expenditure is somewhat less. The actual figures for the years 1970–71 and 1986–87 are, respectively, Rs. 1.4 billion and Rs. 26.68 billion. If one takes 1970–71 as the base year and a 10% inflation rate, the real expenditure for 1986–87 is only Rs. 5.81 billion.

The money for R&D is shared between major scientific agencies on the one hand and government departments engaged in technological work on the other. In the former category are DAE, DOS (Department of Space), DRDO, etc., while the latter includes the Department of Telecommunication, the Ministry of Steel, etc. Figure 4 gives a feel for the way the resources are shared by these two major groups. Among the scientific agencies themselves, the pattern of distribution is as shown in Figure 5.

Into which sectors is the money going? The answer to this is available in Figure 6.

The comment is often heard that we are not spending as much on research as many other countries are. How exactly do we compare with others? Figure 7 gives the picture in terms of percentage of GNP while Table 1 gives absolute numbers, which, perhaps, are more meaningful.

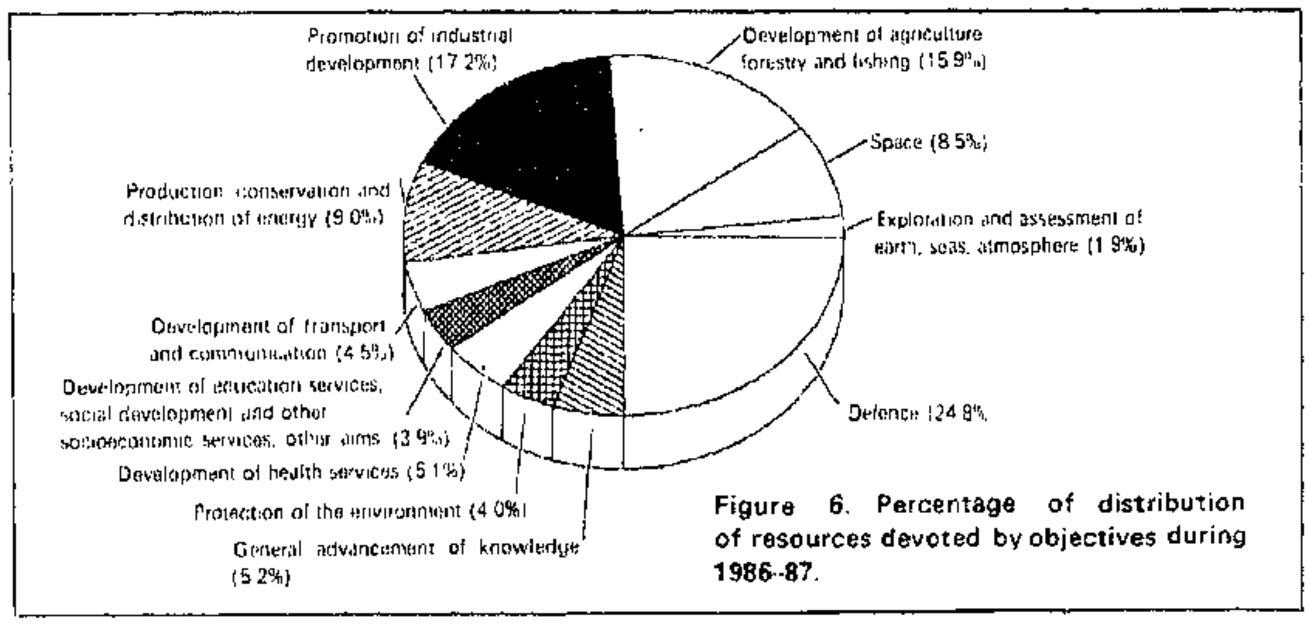

Figure 6. Percentage of distribution of resources devoted by objectives during 1986–87.

Table 1. Per capita R&D expenditure in US dollars for some selected countries grouped by per capita GNP in US dollars.

Per capita GNP below $500		Per capita GNP between $500 and 2000		Per capita GNP between $2000 and 5000		Per capita GNP between $5000 and 10,000		Per capita GNP above $10,000	
India	2.78 (1986)	Cuba	18.22 (1984)	Brazil	13.41 (1982)	Austria	103.13 (1981)	Australia	117.47 (1981)
Indonesia	1.85 (1983)	Egypt	1.29 (1982)	USSR	117.88 (1984)	Czechoslovakia	105.95 (1984)	Canada	175.29 (1983)
Pakistan	0.48 (1979)	Hungary	44.21 (1984)	Yugoslavia	23.24 (1981)	GDR	171.57 (1984)	FRG	275.97 (1981)
		Rep. of Korea	19.98 (1983)			Italy	69.41 (1983)	France	194.31 (1979)
		Nigeria	2.17 (1977)			Japan	254.14 (1983)	Sweden	284.96 (1983)
		Philippines	1.21 (1982)			UK	212.25 (1981)	USA	376.10 (1983)

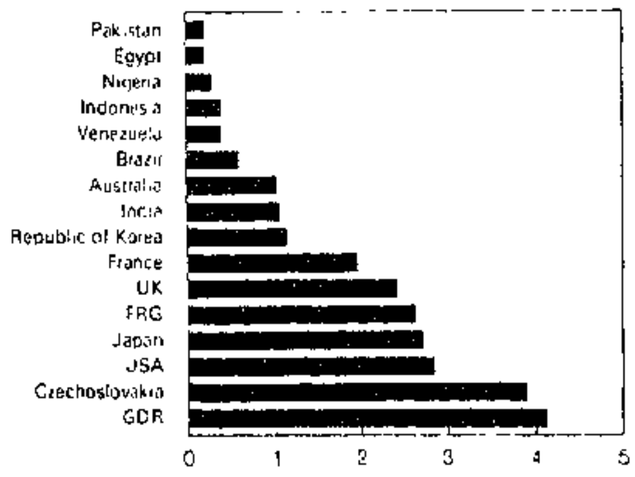

Figure 7. R&D expenditure as percentage of GNP for selected countries.

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