may be entertained of the co-ordinated progress of the nation, with sufficient leisure and tranquillity to devote time and talents to the enrichment of their home and environment.

No one can be more vividly conscious of the limitations of science than he who has lived it, and its function is 'no more to save our bodies than it is to save our souls'. It seeks to uncover the veil of nature and deals with her facts and phenomena disclosing new worlds of thought, reality, laws and history of the visible universe. With the more technical parts of science, the general public can have very little to do, but it ought to be possible for those who have attained a reasonably high degree of education to become acquainted with the general advances of those departments of knowledge in which they are most interested or in which they have received their earlier training. To democratise science need not necessarily involve its degradation. At present the whole firmament of public life is dark, illumined here and there by a few stars of the first magnitude whose glory is scarcely discernible in the immense general gloom of the sky. What Professor Einstein wishes is a widespread diffusion of light throughout this vast area, each body in it having the power of self-luminescence. It would be too narrow a view to take that the task of science begins and ends with research; for if the knowledge of science is good then it must be good for something and for somebody. It is perfectly legitimate for the scientist to emerge from the laboratory and give the people who care, an account of the joys and pleasures and the difficulties and trials in the prosecution of his studies and make them feel the same thrills, and participate in the cultural benefits which may have accrued to the investigator himself. All the agencies that are impressed in this task, viz. the Universities, the learned societies, the scientific associations and congresses and the press, have established wide channels of communicating knowledge to the general public, but their efforts are obscured by causes over which science has little control. We have to cure the gold fever before science can come to its own.

In India the task is far harder. Education has scarcely touched the outer fringe of the vast population. Those who have received the benefits of education are interested in matters and problems far removed from science. The younger generation is concerned more with the task of obtaining a livelihood than with extra courses of studies for the cultivation of mind. Those that have worldly goods, leisure and a fair measure of tranquillity are engrossed with activities naturally befitting their station in life. To the businessmen science is a superfluity. The Indian universities are nevertheless engaged in overcoming the inertia and in improving the pace of life in the right direction; but it will certainly take a long time for an exotic knowledge conveyed best in the foreign language to permeate and enlighten the whole of the Indian population. Whether it be in India or in any country, public life when freed from the tyranny of gold will instinctively seek knowledge, create leisure for the enjoyment of the beauties of art and literature, acquire power to visualise the higher ideals and the ambitions of a larger life than the one circumscribed by the narrow limits of industries, commerce and lop-sided progress.

Science content in IIT engineering education

S. C. Dutta Roy

At the Indian Institutes of Technology (IITs), why should we bother about science content in the curriculum? Apparently, we should not, because of two reasons. First, irrespective of the contents, our graduates are the most wanted commodities in India as well as abroad. Secondly, whatever the contents are – of science or engineering, and whatever the discipline is – civil, electrical or textile, most of our graduates run after jobs in software or management, which have very little to do with what they learn in the curriculum.

The science content in the IIT engineering curriculum has undergone a drastic cut after the transition from 5 years' to 4 years' duration – from 15 to 20% to an average of 10%. In this 10% also, in the name of basic sciences, every department tries to find out courses which are intimately related to the discipline, so much so that some of the chosen courses could as well be considered as belonging to the departmental core. As an example, in one IIT, there is a solitary course in Physics, on Electromagnetic Theory, to fulfil the Physics requirements of a B Tech Electrical Engineering (EE) curriculum!

The arguments in favour of the drastic reduction in basic science courses are basically three in number. First, with the reduced duration of the programme, it would not otherwise be possible to accommodate all aspects of the particular discipline. Second, it is assumed that the 10 + 2 level science background is adequate. Thirdly, it is essential to accommodate a number of computer-related courses in each discipline. The first argument is hardly tenable, because if a student is exposed to the major aspects of a discipline, then he can himself learn and grasp the other aspects. As to the second argument, even a casual examination of the 10 + 2 curriculum will reveal that this is not true either. The school syllabus is heavily crowded, and therefore necessarily shallow, and the choice of topics is haphazard. In addition, the available text books are full of inconsistencies – printing as well as otherwise. The third argument is quite a valid one, but one should not overdo it. Routine programming techniques, for example, should be left to the students to be learnt by practice.

When we go out of IITs and look at the curriculum of other Universities, the situation is somewhat varied, but the general trend towards reducing science content is clearly visible. In a recent curriculum revision, some Universities in Tamil Nadu have reduced Physics and Chemistry contents of the engineering curriculum to just one course, called Physical Sciences Theory and Practice (Kaniappan, K., *Curr. Sci.*, 1999, **76**, 1173). This is an extreme situation; it could, of course, be worse, where all basic sciences could be thrown out of the engineering curriculum.

The founding fathers of the IIT system had the vision that IITs would impart what is called 'science-based engineering education', the products of which would be rich in knowledge and simultaneously have the competence to retrieve and use information pertinent to the discipline. The knowledge-base, rather than information-base, would make them engineering innovators who would foresee and work for what is to come in the future. In other words, IIT graduates would be most suitable for engineering research, development and innovation. By and large, our initial curricula were designed with this end in view, but over the years, the vision seems to have been blurred to a great extent, yielding place to primarily information-based course work.

Some IIT teachers argue that our basic science content may be low, but we do teach engineering sciences. A careful examination shows that even here, the trend is to push the relevant discipline subjects to these slots. For example, an EE Department names Electronic Circuits and Electrical Machines, which are hard core EE subjects, to fulfil the needs of engineering sciences. What is more, in some disciplines, even the science content relevant to the discipline has been relegated to the elective list or thrown out altogether. A case in point is the course on Physical Electronics, which is now an elective in one IIT's EE curriculum.

It appears to me that a hard and discipline delinked look is urgently needed at the science content in engineering curriculum, and the necessary corrective actions have to be initiated in order to motivate at least some of our bright graduates towards engineering research, design, development and innovation.

In the general atmosphere of globalization and liberalization, it is the common impression that one can import almost anything for the price. This is not, however, true in the case of technology or hardware related to our crucial national needs in some sectors like defence and space. One realizes this only when the nation faces sanctions from a developed country like the USA; in that challenging situation, we are forced to work for indigenous development. Such challenges are likely to increase in the future, and the best brains and the best trained minds are needed to meet the same. People having science-based engineering training would prove invaluable in such situations.

There have been several attempts at rationalizing the 10 + 2 education in science, but no substantial change seems to have resulted. In this context, I am of the opinion that the two years' intermediate science programme in colleges, after ten years of school, was much more effective in preparing the science background needed for engineering. I myself went through such a programme, and I vividly remember how exciting those days were, with every lecture unfolding new knowledge in a manner quite different from what we were used to in schools. Every Physics and Chemistry lecture was accompanied by live demonstrations in the class room which left an indelible impression in our young minds. Can we go back to that system?

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SCIENTIFIC CORRESPONDENCE

Crystal structure of cyclonite

Cyclonite, also known as hexagen, RDX and T4 is an important explosive. It achieved great importance during World War II and was first prepared by Lenz[1]. Cyclonite was used in detonators, primers, boosters and in mixtures with trinitrotoluene. Cyclonite has a high chemical stability and great explosive power. In our forensic science laboratory, we receive samples of various explosives including cyclonite for analysis.

Cyclonite is a white substance in crystal form. The refractive index varies from 1.57 to 1.60 and the melting point is 202°C to 207°C. The specific heat is 0.3 cal/g°C, and the heat of combustion is 2285 kcal/kg. It is an endothermic compound and this factor renders it highly explosive. It has a specific gravity of 1.820 and it is practically insoluble in water and carbon disulphide. In most organic liquids cyclonite dissolves with difficulty. The best solvent in which it dissolves is acetone, at the rate of 8.38 g/100 g of acetone at 30°C, it can be recrystallized from this. On explosion, cyclonite decomposes with the evolution of CO 25.22%, CO_2 19.82%, H_2O 16.32%, H_2 0.90%, N_2 37.83% at a