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Guest Editorial

THE ANALYSIS of engineering education systems around the world shows that while different countries have similar development objectives, they adopt different strategies for achieving them. These are a function of the availability of resources—both physical and human—the type of political system, social and cultural traditions, etc. The VDI (Verein Deutscher Ingenieure) of Germany published about seven years ago a series of articles in *VDI Nachrichten* wherein the engineering education systems in eight selected industrial nations were critically reviewed. The information was mainly intended for the benefit of students who wished to study abroad and multinational companies who wished to make use of the services of engineers trained abroad. The analysis revealed a wide diversity in preparatory systems, context and structure of the curricula, stress on theoretical and practical studies, requirement of practical training, etc. Another point of divergence was the generalist versus specialist orientation of the engineering programmes. All these serve to bring out the complexity of the processes of engineering education.

In post-independence India, the goals of education have been tuned to be in line with national goals and aspirations. These include economic development for furthering the material well-being of people, social and political development for living harmoniously and promoting a democratic and just society, and the intellectual, cultural and aesthetic development for enrichment of the quality of life. Two major efforts have been mounted, the first in 1968, and the second in 1986, to formulate the National Education Policy. The latter was followed up by a detailed Programme of Action, indicating the seriousness with which it was intended to be implemented.

In most Indian states, the pattern is 5 years of primary education followed by 3 years of middle school; in some states the pattern is 4 + 3 or 4 + 4. The secondary/higher secondary schools are also not of a uniform pattern throughout the country. While most follow the new pattern of 10 + 2, others follow 11 + 1. The growth of vocational education, as a part of uniform nationwide pattern, began with the introduction of the 10 + 2 pattern. More than half of the 1600 vocational institutions existing in the country in 1983–84 were in Tamil Nadu. The programme of 'Universalization of Elementary Education' includes education up to class VIII.

Figure 1 shows the structure of the overall system in India.

The *Universities Handbook*, published by the Association of Indian Universities every year, gives comprehensive information about all the educational institutions in India. Ten institutions are designated as institutes of national importance: the five IITs, the Indian Institute of Science, the Indian Statistical Institute, three medical science institutions and one Hindi language institution. In addition, there are four Indian Institutes of Management which provide advanced management education leading to postgraduate diplomas.

The largest number of universities in India belong to the affiliating and teaching type, in which university departments impart instruction at the postgraduate level and undertake research. These universities have a large number of degree colleges offering undergraduate education affiliated to them. Some colleges also have postgraduate teaching and research. Some of the universities have over 100 affiliated colleges and over 100,000 students enrolled.

A second type is the *unitary* universities like Aligarh, Annamalai, Banaras, Baroda, Jadavpur and Lucknow. These do not have major responsibilities in respect of affiliated colleges. There are also some universities which are in some sense a mixture of the above two types. Their territorial jurisdiction is usually confined to the city in which the university is located. The colleges located within the city are affiliated to the university. Some of the colleges are, however, managed by the university and are known as its *constituent* colleges. Delhi University is a typical example.

A new type of institution in higher education is provided by the agricultural universities, established on the American pattern of land grant universities, with stress on research and extension work. A substantial part of the funding of these universities comes from the Indian Council of Agricultural Research.

Another new category is the technological university. The first in this category was established as the University of Roorkee in 1949, when the prestigious Thompson College of Engineering (established in 1847) was upgraded to university status. Other universities in this category are the Jawaharlal Nehru Technological University at Hyderabad and the Anna University at Madras. Jadavpur University at Calcutta is a mixture of this and the conventional types.

Some institutions of higher education have been recognized by the central government as institutions 'deemed to be universities'. Such institutions are required to 'generally aim at strengthening its activities in its field of specialization rather than make efforts towards growing into multi-faculty university of the general types'. The creation of such deemed universities is the exclusive responsibility of the central government on the basis of a recommendation from the University Grants Commission (UGC).

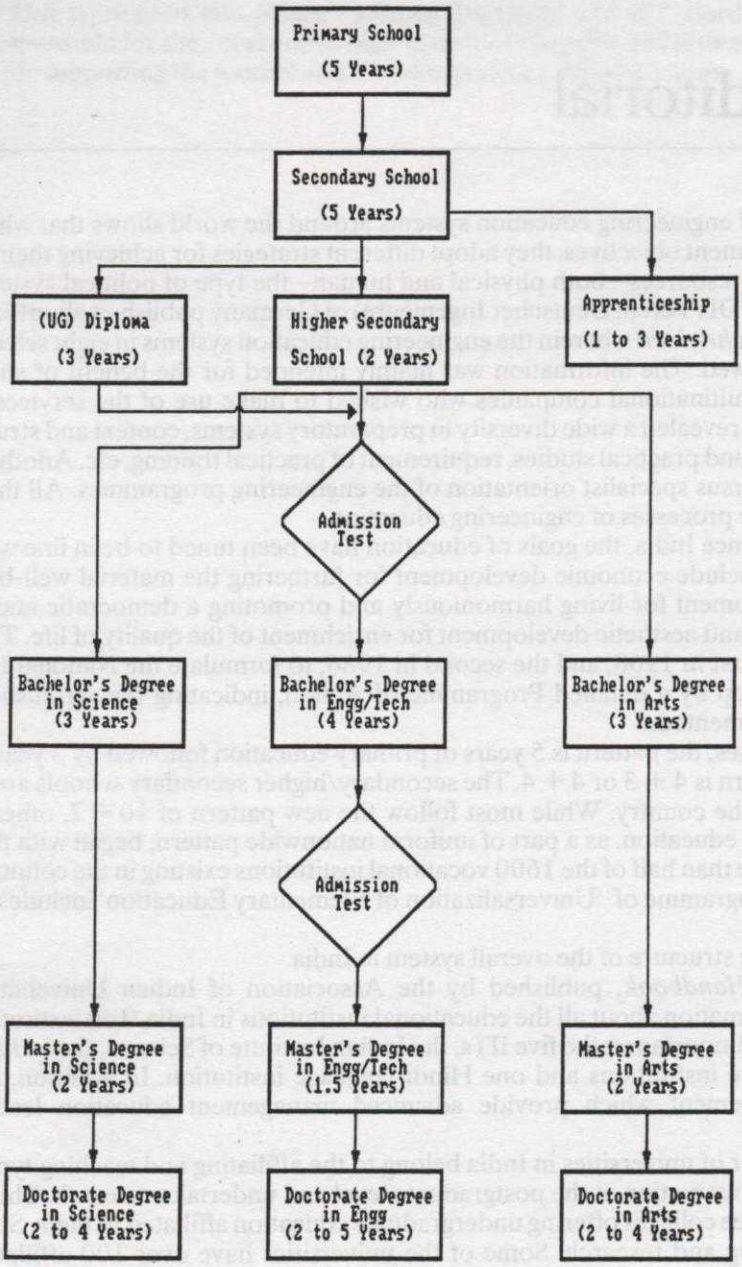

Fig. 1. The structure of the education system in India.

As regards governance, 10 are central universities (including the Indira Gandhi National Open University) established by acts of parliament. The others are state universities established by the state legislatures. Some states have a common universities act for all the universities.

As regards funding, the central universities receive funds from the UGC as development (plan) grants and maintenance (non-plan) grants. The institutes of national importance receive their grants directly from the Ministry of Human Resource Development (MHRD). State universities are funded by the state governments in the form of block/maintenance grants as well as development grants. State universities also receive development grants from the UGC provided a matching component is given by the state government according to a prescribed formula.

According to the Indian constitution, which came into force in 1951, higher education is as much a responsibility of the central government as of the states. It is in terms of these provisions in the constitution that the UGC was established in 1956. Unlike the UGC in the UK and other Commonwealth countries, the UGC in India is a statutory body and is required to regulate academic standards in addition to giving funds. The UGC in India is both a grant-giving and a co-ordinating body for academic purposes.

Educational expenditure of all types and at all levels has been growing along with the expansion of the system. Education is the second highest sector of budgeted expenditure. A little more than 3% of the GNP is

spent on education. The total expenditure consists of two types: plan, which is the developmental expenditure consisting of expenditure on new schemes/programmes; and non-plan, which denotes the maintenance expenditure on ongoing schemes/programmes. During a five-year plan, the ratio of plan to non-plan expenditure keeps on increasing as one moves from the first year to the fifth year of the plan.

Among all the developmental linkages, the relationship between education and employment is of great significance. To a large extent, the growth and development of education is tied up with employment and work. Since a large proportion of the labour force is either illiterate or is only marginally educated, most of the educated labour is concentrated in only a few selected occupational groups. Since independence, the public sector has played an important role in India's socio-economic development. It has emerged as the largest employer of the educated manpower.

The modernization of the industrial sector served to give increasing importance to the completion of formal educational programmes as a prerequisite for employment. The close nexus between the labour market and the education system is at the heart of the manpower planning process. There is a reciprocal relationship between educational planning and manpower planning. The policy for human resource development in the context of national development requires the analysis of the skills needed for the various activities to be performed in different sectors of the economy. Conversely, the output of the education system, in terms of the various skills and knowledge imparted, has to be known for proper utilization of the human resources it generates. In order to plan the education system in terms of intake, content and structure, it is necessary to estimate the demands for such output in quantitative and qualitative terms. A mismatch between manpower demand and the development of higher and technical education results in unemployment or under-employment.

Educational and employment policies are being revised in many countries of the world in favour of schemes for bridging the gap between education and employment with relevant occupational training. In several countries, it has been found that while teenage unemployment is now decreasing because of the proliferation of education and training schemes, unemployment in the higher age groups has been increasing considerably.

The education sector considered above is the 'formal' system of education. Even within this sector, a distinction needs to be made between professional and non-professional education. In most countries, a clear distinction is usually made between academic programmes with emphasis on preparation for as well as transfer to higher education, and technical vocational courses with a stronger employment orientation. In this context, a very interesting distinction has been observed in the case of North American and Western European countries. While in the former, more than two-thirds of the students enrol in general academic programmes with the remainder taking vocational courses, in the latter case, it is the other way around. The difference is attributed at least partly to the fact that while basic schooling is still considered to end at the lower secondary level in the Western European countries, in the USA and Canada, basic schooling is more commonly associated with full secondary education. These countries, therefore, place more emphasis on providing a common educational core and the socialization process for students in the later years of secondary schools, thus leaving vocational education and training for the post-secondary level. In the Indian context, there is an urgent need to develop alternatives between the strictly academic and the narrow vocational options which would be better suited to changing working and societal needs, as well as to the interests and abilities of the young people who are likely to leave education after the upper secondary level.

An analysis of the distribution of enrolment among science and engineering, and arts-based subjects reveals some interesting factors. While the former two perform most of the productive activities in the economy, the latter are mostly involved in the service sector. In most of the developing countries, when social pressures lead to the expansion of higher education without a proportionate increase in the share of the budget, expansion is resorted to in the areas where the costs are minimal. This leads to a much faster rate of increase in enrolments in the arts-based courses.

One of the important reasons for unemployment among educated graduates is the rapid quantitative expansion of higher education, especially in the context of the persistence of economic stagnation. This is doubly disconcerting: first, because of the large investment in higher education; and second, the frustration and unfulfilled expectations resulting from unemployment, leading to serious social problems. In most Asian countries, it has been established that expansion in higher education has ignored the problem of employability of the graduates. Contrary to the belief that a significant proportion pursue higher education for its own sake, it is established that students pursue higher education for better employment opportunities. While self-employment is offered as a means of relieving pressure on the organized employment sector, it must be recognized that self-employment calls for specially oriented educational programmes. However, there is no well-defined policy on higher education for self-employment. If education is considered to be a basic human right, gainful employment will also be demanded as a basic human right, because it is the means for survival.

One of the strategies suggested in the National Education Policy–1986 is the delinking of degrees from jobs in order to relieve the burgeoning pressures on the education system, particularly on higher education. Whether this is necessary or possible for all types of jobs is a moot question. By delinking degrees from jobs, and substituting training for education before people become employable or resorting to on-the-job training, we may be pushing down the age at which people seek employment. Instead of having highly qualified

unemployed people we will end up with less-qualified unemployed people. However, it would be much easier to demonstrate the relevance and provide the motivation and incentive to the students in that case. A logical consequence of the above argument is that in the face of a rapidly expanding population and a dearth of adequate employment opportunities, the basic problem to be tackled is population control; without it, all the other efforts can only provide marginal relief.

It is often stated in the various media that India possesses the 'third' largest pool of science and technology manpower in the world. In 1989, the then Secretary, Department of Science and Technology, Dr Vasant Gowariker (currently scientific adviser to the Prime Minister), examined this statement against existing data and found it to be without basis. He also found that

> firm and latest data on S&T manpower, with uniformly defined terms, from various countries are just not available. On the basis of whatever data are available, India stood at number 14 in the world in the matter of total S&T manpower stock (which includes scientists, engineers and technicians) in 1985, when compared with other countries whose figures relate to one or the other year during 1980 to 1986); Japan, USSR, FRG and China, respectively, occupied the first four positions, with the USA at number 11 with its 1976 figures. If we just take scientists and engineers, India stands at number 5 in the world, with the first four places taken by USSR, Japan, USA and FRG. In the matter of stock of technicians, India ranks 17, with the first four places, respectively, going to Japan, USSR, FRG and Canada.

In an earlier issue of this journal [Vol. 8, no. 1, pp. 22–35 (1992)] an overall perspective was presented of the present status of technical education in India. At the instance of Professor Wald, I undertook the task of enlarging the scope of the paper, inviting articles from distinguished academicians and academic administrators in the country and from countries with which India has bilateral co-operation. While our objectives have been, by and large, met, it has not been possible to cover the originally intended total spectrum.

Since we started planning for this Issue about a year ago, some major changes have occurred in the administration and management of technical education in the country. A full-time Chairman has been appointed for the AICTE, and eight Buaus have been formed to better coordinate the several activities under the purview of the AICTE. The tasks and action plan have been articulated in a document released recently to coincide with the shifting of the headquarters. It proposes an agenda for action designed to plan, coordinate and integrate the development of the Technical Education System throughout the country.

It is hoped that the case study of the engineering education system in India discussed here will serve to highlight the aspirations and experiences of a developing country in its quest for exploiting science and technology for national economic development.

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