Journal of Academia and Industrial Research (JAIR)
Volume 3, Issue 3 August 2014

ISSN: 2278-5213

REVIEW ARTICLE

Expansion of Engineering Education in India: Issues, Challenges and Achievable Suggestions

Neeraj Sharma
Dept. of Electronics and Communication Engineering, University Institute of Engineering and Technology, Panjab University SSG Regional Centre, Hoshiarpur-146021, India
sharmaneerajpu@gmail.com; +91 9023418104

Abstract

The exponential rise in the number of engineering institutions in the last two decades in India has facilitated the entry of aspiring students into engineering institutions and provided the much needed manpower for industries. But the quality of education in most of these institutes remains questionable. There may be many factors leading to this scenario, but the most important seems to be the motive of profit making than providing quality education. Though premier engineering institutes like the Indian Institutes of Technology are credited with providing excellent undergraduate engineering education; yet this achievement did not reach their postgraduate engineering courses. In this review, some issues arising out of quantitative growth of engineering education are identified and an attempt is made to analyze the reasons for this condition and some achievable suggestions are presented.

Keywords: Engineering education, national board of accreditation, Washington accord, accreditation.

Introduction

Engineering education in India starts from craftsman level to post doctoral level to meet the needs of technical manpower in the country. Each level has its significant role. Establishment of the five Indian Institutes of Technology (IITs) later followed by Regional Engineering Colleges (renamed as National Institutes of Technology; NITs) soon after gaining independence was a major decision. It paid rich dividends by providing world-class engineering education at the undergraduate (UG) level, which is as good as or even better than anywhere in the world. Today with the expansion of engineering education in India, there are more than 3500 engineering institutes in the country producing around 1.5 million engineering students annually (Rama Rao, 2013). This tremendous quantitative growth has posed the problem of maintaining the quality of the engineering education in the country. This review will concentrate on issues dealing with various aspects of UG level with some emphasis on postgraduate (PG) and doctoral level in engineering.

Important developments during British rule

The beginning of formal Technical Education in India started in the mid of 19th century. The foundation of this education in India was laid almost at the same time as in Europe, but its growth in our country was very slow till India gained independence. Initially, technical schools for Land Surveying were given high priority to train persons for land surveying for Government works. The first such school was opened in 1794 in Chennai. Later on, technical education spread its wings to other parts of the country and engineering colleges were established in various parts of India–Chennai in south (1794), Roorkee in north (1847), Pune in west (1854) and Kolkata in east (1856) to train the engineers required for various engineering activities in the country. The *Swadeshi* (meaning 'of our own country') movement which started gaining momentum in the early 20th century lead to desire for *Swadeshi* education also. Many educational institutions, set up by private initiatives, were established at various places. Prominent among these were the Indian Institute of Science (IISc), Bangalore by the house of Tatas (1908), which became operational in 1911 and the Banaras Hindu University (BHU) by Pandit Madan Mohan Malaviya in 1916. An engineering college was started in 1919 in BHU campus. All of these are prestigious technical institutions of the country even today. An important step with far reaching consequences taken in the pre-independence period was the constitution of the Sarkar Committee in 1945. This committee was made to suggest measures to meet the post-war requirements of the country with reference to high grade technical manpower. It recommended the setting up of at least four higher technical institutions on lines with the Massachusetts Institute of Technology (MIT) USA spanning the length and breadth of India.

Growth of engineering education during post-independence period

At the time of gaining independence in 1947, the number of engineering colleges and polytechnics were 44 and 43 respectively with an annual intake capacity of 3200 and 3400 respectively (AICTE, 2011-2012). To carry out development plans, the country needed expansion of

technical education on urgent basis to provide trained human power for industries and other technical services.

Indian Institutes of Technology (IITs): Acting upon the recommendations made by the Sarkar Committee, five IITs were established at Kharagpur (1951), Bombay (1958), Madras (1959), Kanpur (1960) and Delhi (1961) by acts of Parliament (Kakodkar Committee Report, 2011). Recognizing their importance, all were granted the status of Institutions of National Importance (INI). During their early years, the IITs got material and academic assistance from friendly developed countries–IIT Bombay from the USSR, IIT Madras from Germany, IIT Kanpur from the United States of America, and IIT Delhi from England. Later on, sixth IIT was established in Guwahati (1994) to meet the regional aspirations. India's premier technical institute, set up in 1847 in Roorkee and known as the Thomson College of Engineering and subsequently the University of Roorkee, was made the seventh IIT in 2001. Six new IITs were started in Bhubaneswar, Gandhinagar, Hyderabad, Patna, Jodhpur and Ropar in 2008 followed by two more in Indore and Mandi in the year 2009. The older IITs are acting as mentors for the new ones. The Institute of Technology at BHU was granted the coveted status of IIT in 2012 and was renamed as IIT (BHU). Recently the Indian Government in its Union budget for the financial year 2014-15 announced the proposal to set up five more IITs in the states of Jammu, Chhattisgarh, Goa, Andhra Pradesh and Kerala. This makes a total of 16 operational and five upcoming IITs in the country. The faculty and alumni of IITs have earned reputation for themselves globally and put a noticeable impact on different sections of Indian society and abroad. The annual intake capacity of IITs is approximately 10000 at UG and PG levels. Clearly IITs produce a small fraction of total engineering students in India.

National Institutes of Technology (NITs): In the next tier institutions, there are 30 NITs with liberal funding from Central Government and autonomous structure much similar to IITs. These are located in each major state/Union Territory of the country. The NITs were declared INI in 2007. These have been established in the backdrop of Second Five Year Plan (1956-61) to ensure the supply of trained manpower for the industrial projects undertaken during the plan. In the first phase, eight Regional Engineering Colleges (RECs) were set up. All RECs were later renamed and restructured as NITs in 2002.

In the next lower layer, each state has a number of engineering colleges under its control, affiliated to a University and having a limited or no academic autonomy. There has been mushrooming of private engineering colleges due to great demand for engineering education in the last almost two decades, which has lead to degradation in the quality. In a bid to utilize its existing resources in various departments of repute, the Central Government has been encouraging the Departments of Atomic Energy (DAE), Defense Research and Development Organization (DRDO), Indian Space Research Organization (ISRO) and Council of Scientific and Industrial Research (CSIO) to train engineers at the PG level.

Expansion and privatization of engineering education

In the early 1980s, there were about one hundred engineering colleges admitting around 25,000 students each year. Owing to efforts and initiatives taken during successive Five Year Plans and particularly with the implementation of the policy of liberalization and globalization, the number of students passing out of Government institutions became insufficient to cater to the demands of the industry. This forced the Government to allow and facilitate the private players to set up technical institutions on self-financing basis. Since then, there has been mushrooming of engineering institutions. It started with the opening up of about 50 new private engineering colleges in Tamil Nadu over a small period of time. This development was opposed by the academic community at that time, as they thought this would dilute the standard of engineering education. They were proved right, as there were not enough quality teachers. This process continued and as a result within a few years, about five hundred private engineering colleges were operating in the four states of Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra. Today this phenomenon of expansion has reached other parts of the country and India produces 1.5 million engineering students from around 3500 engineering institutions annually. The quality of education in these private colleges is very uneven. Many of these colleges lack even basic facilities essential for good engineering education and have practically no quality teachers at all. But on the other hand, some have excelled and are as good as or even better than many of the Government engineering colleges today. In spite of the varying standards, India has benefitted immensely from this growth. This is evident from the glorious heights; the Indian industry has touched in the past decades. The areas of Information Technology (IT) and telecom industry were the first ones to benefit. Later other areas of Industry got benefitted. As a result, India’s GDP which stood at 3.5% in 1980 rose to 6% between 1980 and 2002 and then to 8% between 2002 and 2006 (Ashok, 2007). The other important benefit was that democratization in some sense has taken place in engineering education in the country. Earlier, it was extremely difficult to get admission in an engineering college due to limited opportunities. Now even those who pass out from small towns and villages, are able to find admissions.

Challenges

There is no doubt that quantitative growth of engineering education in India has increased the opportunities for

engineering aspirants and has contributed to nation's growth. But the maintenance of quality has become the victim of this growth phenomenon. Lack of maintenance of standards in institutions and failure to monitor the same by the regulating bodies is the main factor responsible for this scenario in the country. In the following sub section, challenges faced by UG and PG level of engineering education are discussed.

Undergraduate engineering education: Self-financing private engineering colleges are providing more than 85% of the engineering graduates in the country. According to the National Association of Software and Services Companies (NASSCOM), less than 25% of the graduate engineers are employable. It seems appropriate guidelines and corrective measures are not followed while granting sanctions to new colleges and disciplines. Main motive of the most private colleges is only profit making rather than providing quality education. Even many Government institutions are found lacking in quality education due to political interference resulting in poor governance. Many factor lead to poor quality of education. Some of these are:

- Shortage of quality faculty.
- Inadequate physical infrastructure and funds.
- Lack of autonomy.
- Rigid and outdated curriculum.
- Poor quality of training.
- Absence of R & D activities.
- Poor learner quality.
- Ineffective linkage with industry.

The shortage of quality faculty is the most serious problem confronting Indian engineering education system. Responding to a question in the Upper House of Indian Parliament on 21 July 2015, the concerned minister told that even institutions like the IITs and NITs are facing faculty shortages of about 36% and 41% respectively (The Tribune Newspaper, 22 July 2014). It is a common sight in private engineering colleges for a person who passed with BE/B.Tech degree to start teaching in the following academic year. In fact, the faculty positions in most private colleges are dominated by BE/B.Tech degree holders. There is acute shortage of quality faculty in IT-related disciplines, as industries provide more compensation and benefits than engineering institutions. Table 1 presents faculty shortage in engineering institutes on national basis (Rama Rao, 2013). It is clear that there are ample job opportunities for engineering graduates possessing higher degrees, in academic institutions. What is needed is to make the teaching profession more attractive and rewarding to attract the talented ones.

Table 1. Severe shortage of quality faculty.

Annual intake	15,00,000
Faculty shortage (1: 15 faculty-student ratio)	80,000
Shortage of Ph.Ds	60,000
Shortage of Master's	20,000

There is a complete mismatch between the knowledge gained by the students in engineering colleges and practices followed in the field. Industry often finds the engineering graduates weak in professional skills, which requires them to undergo on the job training for longer durations for making them professionally competent. The emphasis is on passing the examinations alone, rather than learning and acquiring skills. With the options of liberal entry into engineering colleges, many students take to engineering without any aptitude under pressure from their parents or society. This leads to poor learner quality. In recent years, Indian economy has made remarkable progress in service sector bypassing the manufacturing sector. This unconventional path to growth has resulted in rise in emergence of the IT sector, which has also affected the quality of graduates in other traditional engineering disciplines in an interesting manner. Knowing that it is easy to get a job with a good salary in the IT sector, students from other disciplines concentrate more on IT related courses at the cost of their core subjects. They even take coaching in IT related subjects during summer vacation and industrial training. As a result, engineers with average skills are produced, neither good in their own disciplines nor in IT. In addition, there has been too much dependence on software packages in some of the core disciplines, which has lead to poor understanding of concepts. Moreover, over emphasis on soft skills at the cost of core engineering skills during campus interviews has created a wrong notion among students. It is really a tough challenge to make tailor made engineers suitable for specific industry needs, as educational institutions are better suited for providing training of minds and not training for jobs. For this, Regular and well organized interaction between academia and industries is essential as conditions in job market are rapidly changing.

Postgraduate education and research: Unless our premier engineering institutions pay sufficient attention to the PG courses as they did in case of their UG courses during their initial years, they cannot produce good quality PG and Ph.D degree holders. Insignificant numbers of engineering graduates opt for PG studies and Ph.D in India. A comparison of pass outs shown in Table 2 at various degree levels in India and the Unites States is quite revealing in this regard (Subbarao, 2013). The private institutions admit students for UG courses in India, but lack facilities and motivation for running PG courses. This can be linked to well paying industry jobs available to undergraduates from reputed institutions and hence they are least interested to pursue higher studies in engineering. Therefore it is essential to spread quality PG education in the country by making it more rewarding. The IITs are seriously lacking on this front. Less than 2% of IIT graduates go for post graduation and higher research in IITs. These premier institutions were envisioned to be at the forefront in Research & Development (R&D) and produce Ph.D students who would lead research activities in industries

and could serve as excellent teachers for other technical institutions of the nation. The IITs would thus have created a culture of innovation in the country. But in reality, IITs are not even producing enough Ph.D students to fill the faculty positions of their fellow IITs and other institutions. Though IITs produce world-class engineers at UG level, the insufficient quality of research at IITs leading to poor R&D in India, can be judged from the fact that MIT's annual research output in terms of patents is better than that of all the IITs taken together.

Table 2. Engineering students at three levels in India and USA.

	India	USA
Bachelor's	15,00,000	75,000(5% of India)
Master's	75,000(5% of Bachelor's)	37,500(50% of India)
Ph.D	1500(0.1% of Bachelor's)	7500(500% of India)

India still has Advantages!

India still possesses some important advantages which can create opportunities to enable the nation to become a key contributor in the ever growing global knowledge economy (Subbarao, 2013). Some of the key points are:

- Whereas, many leading and developed economies such as US, European countries, China, Japan, etc. do have aging population, India has a relatively young population. This implies that we can provide the work force for the entire world, not just for India.
- English has truly become the language of the global knowledge economy. India is fortunate to have the largest number of English-speaking people, probably next to the US.
- Leading institutions e.g. IITs, NITs and other premier institutes have given India a worldwide recognition and hence have the potential to attract and enroll more international students. This will bring the much needed student interactions and strengthen the institutions financially.
- India has a wide and improving Information and Communication Technology (ICT) network. This facility can be used to provide quality engineering education in remote and rural areas.
- The average per capita income of the middle class population in India is growing reasonably well. This directly results into market for more manufactured goods and at the same time demand for quality education. With increase in income, people would be able to spend more on education and hence the demand for quality education will rise naturally.

These advantages will bear fruits for the country, only if different stake holders play their role well and the Government takes firm steps to remove various obstacles in the way.

Suggestions

Following are some of the suggestion which can improve the present state of affairs in the sector of engineering education in India:

- To reduce the faculty crunch, retired faculty should be hired and the services of qualified engineers from the industry and R&D institutions can be taken in academic institutions.
- To make teaching profession more attractive, exiting and research-oriented, financial and other incentives such as research grants should be offered to perspective and existing teachers. Better performing teachers should be rewarded with higher remuneration.
- As an immediate measure, the advancements made in the area of ICT can be utilized to reform and expedite the process of knowledge dissemination in engineering institutions. With the availability of teleconferencing equipment at affordable price, it is not difficult to broadcast lectures delivered by teachers in one institution into the classrooms of any remote engineering college. More awareness among faculty and students should be created to utilize free online course ware from MIT in USA and National Programme on Technology Enhanced Learning (NPTEL) courses offered by the IITs and IISc in India.
- It should be mandatory for all engineering colleges, private or public, to depute some faculty members per year for obtaining higher degree.
- Greater autonomy to the institutes and teachers is the need of the hour. The autonomy of a teacher is the precondition for his successful functioning. As a member of society, a teacher has the additional function of facilitating the process of social transformation also. He should not be forced to just follow the instructions of the administrators, but should be given adequate autonomy and academic freedom to carry and express his ideas. The example of IITs is before us to emulate in this respect.
- The industry and R&D organizations should be encouraged to send their engineers for PG studies with ample incentives. Research projects should involve cooperation and collaboration between academia and industry.
- Indian academic institutions should be encouraged and facilitated to forge close academic collaboration with foreign universities by way of exchange of faculty and students. More opportunities should be created for joint collaboration and research. One of the factors contributing to the success of IITs is the close collaboration with foreign institutions.
- Only those engineering institutions should be allowed to function who achieve accreditation of their streams within specified time frame.

The main challenge is to create an academic environment and education system that promotes and ensures learning. The process is quite challenging, but not impossible to achieve with honest efforts.

Accreditation of engineering courses

National Board of Accreditation (NBA) is entrusted with the task of periodically evaluating technical institutions

and programs based on the norms and standards laid down by the All India Council of Technical Education (AICTE). The motive of accreditation is to encourage excellence in technical institutions at the UG and PG levels. NBA was established in 1994 by AICTE. NBA changed its accreditation norms and procedure in 2009 to be in tune with international standards as per the Washington Accord which requires its member countries to exercise uniform norms in technical education at UG level. India finally became the 17th member of the Washington Accord recently on 13th June 2014 (The Times of India Newspaper, 14 June 2014). It will help create equivalence of engineering degree courses and allow Indians to practice engineering in other member countries. NBA has shortlisted 220 engineering colleges as tier-I institutes whose UG engineering programmes are in tune with what is required under the accord. Washington Accord will, however, not be valid for IT engineers. India will have to sign the Seoul Accord to create similar equivalence of programmes.

Conclusion

The growth of engineering education since the last two decades has been phenomenal with the entry of private players in the country. The quality of most of these engineering institutes is questionable given the fact that employability skills are missing among the pass outs. The premier institutes are producing very small number of engineering talent at all degree levels. There is urgent need to address the problems ailing the technical education otherwise India will miss the opportunity to utilize its demographic dividend of a young work force which it has. In order to ensure standards as per global norms and mechanism to monitor the same, uncompromising attitude is essential. In this respect, India becoming a permanent member of the Washington Accord is a significant step.

Acknowledgements

Author is grateful to Dr. Sukhvinder Singh Bamber for his valuable comments.

References

1. Rama Rao, P. 2013. Higher technical education in India: Prospects, challenges and the way forward. INSA Public Lecture, New Delhi.
2. Kakodkar Committee Report. 2011. Taking IITs to excellence and greater relevance, Submitted to Ministry of HRD, Govt. of India.
3. Ashok, J. 2007. Indian higher education dilemma. Article retrieved from http://tenet.res.in/Education_dilemma.pdf
4. Subbarao, E.C. 2013. India's higher engineering education: Opportunities and tough choices. *Curr. Sci.* 104: 1.
5. AICTE. 2011-12. All India Council for Technical Education Approval Process Handbook.
6. The Times of India Newspaper, 14 June 2014. Boost for engineers: India now part of Washington Accord.
7. The Tribune Newspaper, 22 July 2014. 36% teaching slots vacant in 16 IITs.