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Self Sufficiency in Higher Engineering Education in India

Somendra K. Mazumder
Former AICTE Emeritus Fellow and Professor of Civil Engineering
Delhi College of Engineering/ Delhi Technological University (DCE/DTU)

Abstract

Self-sufficiency in higher engineering education in India plays a significant role in meeting the socio-economic goals for the development of the country. Except IITs/IIMs/IIESTs/IISCs, the quality of graduates and post-graduates in engineering from the majority of the technical institutions in India is not up to the mark. Most of the institutions do not have sufficient qualified and trained teachers/ technicians and adequate infrastructures. Majority of the bright and meritorious students in engineering & technology leave India for higher education and research abroad due to better infrastructures, higher remuneration and due recognition of their work. The present status and quality of technical education and research institutions in India has been critically examined with a view to improve quality of the engineers coming out of their portals. The need for collaboration between educational, research and consultancy institutions in promoting quality has been emphasized.

Key Words: AICTE, Collaboration, Consultancy, Quality, Research, Technical Education

Introduction

India, with a population of 1345 million, is the largest democracy in the world. It possesses a large pool of technical manpower which is created from an annual intake of about 14,34,514 engineers for the graduate and post graduate programmes from 3,087 institutions, and 10,07,578 for the Diploma programme from 3658 institutions in engineering and technology as in 2020-21. (Table- 2.3.4 & 2.3.6 of AICTE Annual Report 2020-2021.) Zone wise distribution of intake in all types of technical education (including engineering & technology) in 9,638 institutions approved by AICTE is given in Appendix-A (AICTE Report, 2020-21), which includes 8 programmes viz. Applied Arts & Crafts, Architecture & Planning, Design, Engineering and Technology, Hotel Management and Catering, Management, MCA, and Pharmacy. The engineering educators and practicing engineers must work together and make pro-active efforts to prepare engineering education to address the technology and societal challenges and opportunities of the future (Chaturvedi, 2019). Research and development must have strong linkages with industry for meeting socio-economic goals (Mazumder, 2014, 2017a,b). University professors and the young research scholars working under the professors comprise an enormous pool of expertise and resources which must be tapped to solve many challenging problems faced by the society in the fast changing world with global competition.

This paper discusses some fundamental issues related to the quality of higher engineering education in India.

Appendix-A

Region-wise, State-wise, Level-wise no. of Institutions with Approved Intake (2020-21)

Region	State	Approved Intake			Institutions			Institution	Approved Intake
		Diploma	PG	UG	Diploma	PG	UG		
Central	Chhattisgarh	11,204	4,048	14,703	75	56	49	111	29,955
	Gujarat	57,368	22,502	55,870	156	257	196	396	1,35,740
	Madhya Pradesh	43,786	72,201	83,286	265	554	308	644	1,99,273
Central Total		**1,12,358**	**98,751**	**1,53,859**	**496**	**867**	**553**	**1,151**	**3,64,968**
Eastern	Andaman and Nicobar Islands	480	0	90	3	0	1	2	570
	Arunachal Pradesh	888	228	360	9	3	1	10	1,476
	Assam	5,430	1,924	5,585	36	33	29	68	12,939
	Jharkhand	15,222	3,143	6,710	60	26	26	86	25,075
	Manipur	210	36	150	2	1	1	3	396
	Meghalaya	370	150	630	5	2	2	7	1,150
	Mizoram	270	92	180	4	2	2	5	542
	Nagaland	525	30	180	9	1	2	12	735
	Odisha	47,684	19,111	39,393	172	195	113	316	1,06,188
	Sikkim	525	225	840	2	4	4	6	1,590
	Tripura	1,330	261	660	10	4	3	14	2,251
	West Bengal	41,690	9,820	37,720	206	134	130	302	89,230
Eastern Total		**1,14,624**	**35,020**	**92,498**	**518**	**405**	**314**	**831**	**2,42,142**
Northern	Bihar	20,045	3,227	15,706	84	47	66	164	38,978
	Uttar Pradesh	1,39,963	52,112	1,04,731	733	600	431	1,122	2,96,806
	Uttarakhand	15,797	5,670	10,648	151	76	54	187	32,115
Northern Total		**1,75,805**	**61,009**	**1,31,085**	**968**	**723**	**551**	**1,473**	**3,67,899**
North-West	Chandigarh	960	930	1,815	10	12	7	16	3,705
	Delhi	5,595	11,529	10,756	25	71	23	79	27,880
	Haryana	36,741	17,234	33,608	164	238	147	309	87,583
	Himachal Pradesh	5,000	974	3,920	34	19	27	57	9,894
	Jammu and Kashmir	5,425	1,404	3,780	36	24	12	55	10,609
	Punjab	39,384	13,665	31,642	190	207	129	309	84,691
	Rajasthan	33,810	11,629	38,771	168	165	131	313	84,210
North-West Total		**1,26,915**	**57,365**	**1,24,292**	**627**	**736**	**476**	**1,138**	**3,08,572**
South-Central	Andhra Pradesh	71,732	81,667	1,61,488	314	787	409	749	3,14,887
	Telangana	42,075	70,354	1,19,188	165	575	289	559	2,31,617
South-Central Total		**1,13,807**	**1,52,021**	**2,80,676**	**479**	**1,362**	**698**	**1,308**	**5,46,504**
Southern	Puducherry	2,392	1,463	7,683	9	17	18	27	11,538
	Tamil Nadu	1,84,371	71,671	2,68,144	501	911	547	1,243	5,24,186
Southern Total		**1,86,763**	**73,134**	**2,75,827**	**510**	**928**	**565**	**1,270**	**5,35,724**

South-West	Karnataka	81,944	51,487	1,18,204	335	486	281	743	2,51,635
	Kerala	27,281	18,626	54,370	112	253	196	353	1,00,277
South-West Total		1,09,225	70,113	1,72,574	447	739	477	1,096	3,51,912
Western	Dadra and Nagar Haveli	390	90	60	1	2	1	3	540
	Daman and Diu	660	0	300	2	0	1	3	960
	Goa	2,923	885	1,590	9	7	9	18	5,398
	Maharashtra	1,24,565	83,246	1,53,134	607	830	582	1,347	3,60,945
Western Total		**1,28,538**	**84,221**	**1,55,084**	**619**	**839**	**593**	**1,371**	**3,67,843**
Grand Total		**10,68,035**	**6,31,634**	**13,85,895**	**4,664**	**6,599**	**4,227**	**9,638**	**30,85,564**

Source: AICTE Annual Report 2020-21, Appendix 2.1

New Education Policy On Higher Education

In the New Education Policy, 2020 (https://lexlife.in/2021), a lot of focus has been laid on high quality research at the Masters and Doctoral levels. Provision has been made with three routes into the Masters' degree - a one-year degree, a two-year degree, and the integrated five-year degree. The Masters' degree will also have a strong research component to strengthen the appropriate professional competence in the domain area, and to prepare students for a research degree. A new National Research Foundation (NRF) will focus on funding research within the education system, primarily at colleges and universities. NRF will also bring cohesion among the various research endeavours of multidisciplinary character. Besides providing funding, NRF will also take care of the need to seed and build research capacity in the universities and colleges through a formal mechanism of mentoring that will be instituted. The NRF, will be responsible to:

i) bring in synergies between the stakeholders and research groups,

ii) create a mechanism for monitoring and mid-course corrections,

iii) strengthen the linkages between universities and their counterparts at global level,

iv) catalyse research in universities and colleges, institutions that have hitherto not been big players in the research scene of the country, and

v) help build the capacity to do research through an institutionalised mentoring mechanism involving expert researchers from premier institutions in the country.

Problems In Higher Engineering Education In India

A major problem being faced by the educational, research, consultancy and industrial institutions today is how to attract and retain qualified and meritorious persons (Mazumder, 2017c). A large number of such persons leave the country for higher education abroad for better pay and perks, congenial environment for research, freedom of work and above all due recognition of their achievements. Post graduate study for teaching and research is the last priority in India today. If this situation continues, then educational, research and consultancy institutions have no future and India would be dependent on foreign institutions for higher education, research and consultancy forever. There is therefore a need to deeply introspect and take appropriate measures to bring future engineers in the R&D sector at par with those from the developed countries. The gap between foreign technology and indigenous technology needs to be bridged in future so that the country becomes independent of foreign technology/ knowhow, especially since the public is interested in purchasing quality products even at higher cost.

In an earlier paper Mazumder & Mehrotra, (2019), discussed about the role of R&D in shaping future engineering professionals in India covering several aspects e.g., R&D institutions in India and the current

status of R&D in academic, research and industrial institutions in the country. The role of research publications and professional societies in advancing R&D were emphasised.

Role of Private Technical Institutions for Improving Quality

At the time of Independence, India had only a few engineering colleges engaged in undergraduate education in engineering. Since then, there has been a phenomenal growth in engineering colleges; around 90% of which belong to the private sector. Except a few, most of the private colleges have poor facilities and unqualified faculty, and most of them run only undergraduate programmes. Private engineering colleges are commercially run with the objective of making profit. There is no doubt that engineers coming out from both public and private institutions have made significant contribution for the nation's growth, but the maintaining the quality of education has become the victim of this growth phenomenon. Lack of standards for maintenance of institutions and the education imparted plus the failure to monitor the same by the regulating bodies like AICTE/ UGC is the main factor responsible for the current scenario.

Some of the factors responsible for the poor performance of the private engineering colleges are:

i. Profit is the sole criteria of private investment in education sector. Most of them were established from commercial considerations alone.

ii. Most of the private engineering colleges do not possess adequate faculty and infrastructure. Most of them are run by contractual/ guest teachers who are appointed temporarily and are not paid AICTE approved pay scales.

iii. Majority of the faculty members are old and retired faculty members from public institutions. No institute can prosper without contributions from young and energetic persons.

iv. Very few have postgraduate and PhD. level courses. Except a few, there is hardly any R&D scheme to motivate students for higher learning.

v. These colleges are affiliated to nearby universities which have little say or control in their administration and academics.

vi. Because of high fees, local students who are poor but talented and who come from nearby areas have little opportunity to enter into these colleges.

vii. Rigid and out-dated curriculum.

viii. Ineffective linkage with industry.

Mismanagement In Policy Decision

Technical education as it has developed in India has a distorted image. According to a December, 2008, report from the Indian Institute of Technology (Bombay), IITs and IISc provide only 1% graduates of the total number of students at Bachelor's level, 4% at Master's level, and 40% at PhD level. A direct consequence of this is an enormous but unfortunate growth of private coaching centres in all major cities in India where a large number of students enrol for taking IIT Entrance Test / CEE / GATE. It is not desirable to promote private coaching centres since they have no social significance, charge high coaching fees and are indirectly responsible for deterioration of the secondary and higher secondary education system in the country.

AICTE has recently closed 50% of the private engineering colleges in the country due to lack of enrolment. However, it is the same AICTE which is responsible for approving the private engineering colleges over the years and periodical evaluation of their standard. It would have been better to elevate diploma level institutes to degree level. Instead of de-recognition of the Associate Member of the Institution of Engineers (India) (AMIE) degree offered by the Institution of Engineers (India) {IEI} – a premier professional body of India established in 1920 under a Royal Charter- it would have been prudent to strengthen it by providing a linkage with nearby engineering colleges for laboratory training, etc. AMIE degree holders by and large come from economically weaker section of the society. De-recognition of the AMIE degree as equivalent to graduates from colleges has resulted in loss of opportunity for talented students belonging to

economically weaker section of our society who cannot afford paying large sum of money being charged by public/ private engineering colleges and coaching institutions. AMIE was a route through which many worthy hands in the field and industries could study and obtain a degree which would make them eligible for higher level posts. It also provided an opportunity to persons who wished to qualify/ graduate in other disciplines of engineering of his / her liking – a unique feature not available in the conventional public / private engineering institutions. The Author is well aware that many worthy engineers have contributed immensely in the growth and development of industries and institutes in India after qualifying in AMIE and later improving their qualifications by hard labour and perseverance, while working in institutes / industries.

Current Scenario of Post Graduate Education in India-Shortage of Faculty

In a report by the National Institute of Labour Economics Research and Development (NILERD,2020) submitted to AICTE, it is pointed out that "Indian higher and technical education system is one of the largest system in the world. However, an important challenge being faced by the engineering institutions across the country is the significant number of faculty vacancies and turnover, which is an important factor impeding the institutions from delivering quality education". It further states "Due to many vacancies at senior levels, that is, professor and associate professor levels, learning outcomes in these institutions have continuously been deteriorating. Strategies followed by these institutions for hiring contractual/ adhoc faculties to maintain pupil-teacher ratio as per the norms of AICTE without focusing on quality has destroyed the entire technical education system, affecting outcomes such as the placement ratio, pass-out ratio, and employability of students in most colleges".

The faculty shortage issue has been highlighted and acknowledged at the highest level in the Lok Sabha. Figure-1 indicates the faculty shortage in premier institutions like IITs. More than 50% the faculty positions remained vacant as in 2018.

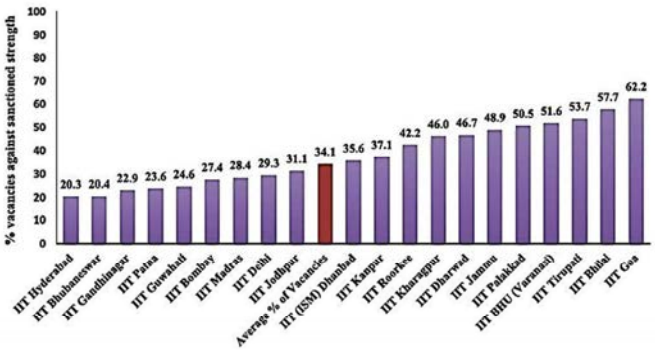

Figure-1: Faculty Vacancies (%) in IITs, as on 31st March, 2018
(Source: Lok Sabha Starred Question No. 434, dated 26 March 2018)

Dr. Manoj Varghese (2019), a senior technology, education technology & innovation leader with over two decades of international experience says "India talks a lot about the Industry readiness of its engineering graduates. Most of the experts in the higher education would bring issues such as outdated curriculum, lack of research, in adequate infrastructure and many more as the reasons for the unemployability of engineering students in India. A very few among them have noticed that, more than a curriculum or infrastructure, India faces a severe shortage of qualified faculty members. Unfortunately, being present for so many years now, faculty shortage has apparently become a permanent feature of Indian Universities".

The UN Rao (2003) Committee had also earlier pointed out that India had a huge shortage of teachers for engineering. For instance in 2000-2001, Indian engineering institutions required a Total of 60,970 teachers, the brake up of which was: 8,710 professors, 17,420 readers and 34,840 lecturers. In terms of professional qualifications, what was required were 26,130 PhDs and 34,840 M Techs. What was available however, were 5,862 PhDs and 11,035 M Tech's. That's a shortfall of around 70%, a figure that has more than doubled over the decade. So, one can imagine the quality of students passing out. With regards to the faculty shortage in Technical Institutions like IITs, the latest survey says that the nation's seven IITs need about 900 additional faculty members before the next academic

session to counteract the shortfall. However, with 27% OBC Quota and 57% increase in the seats the figures will be much higher. A string of measures - including hiring foreigners, raising the retirement age to 70, and incentive packages for new recruits have been suggested by IIT Directors, through alumni and industry networks. IITs are functioning on a 1:11 teacher-student ratio, while the ideal ratio is 1:9. Even in Delhi Universities' Delhi College of Engineering (DCE) the faculty shortage is almost 40%. The colleges also fail to meet the AICTE guidelines as per the faculty and student ratio. Far from the ideal 9 :1 for premier institutes like IITs and the 15 :1 for ordinary engineering colleges, the ration in DCE is 20:1. A shortage in teaching staff often leads to unfinished or hurried course curriculum and inadequate attention to needs of the individual student.

The shortage of quality faculty is the most serious problem confronting the Indian engineering education system. Responding to a question in the Upper House of Indian Parliament on 21st July 2015, the concerned Minister had stated that even institutions like the IITs and NITs were facing faculty shortages of about 36% and 41% respectively (The Tribune, 2014). It is a common in private engineering colleges for a person who passes and gets a BE/B.Tech degree to start teaching in the following academic year. Table-1 presents the faculty shortage in engineering institutes on national basis as mentioned by Rama Rao (2013) in his lecture at INSA.

Table 1. Shortage of Faculty (Rama Rao,2013)

Annual intake	15,00,000
Faculty required @ 1:15 ratio	1,00,000
Faculty shortage	80,000
Shortage of Master Degree holders	20,000
Shortage of Ph.D. Degree holders	60,000

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. In addition, there has been too much dependence on software packages in some of the core disciplines, leading to poor understanding of concepts and thus the ability to judge if the results are correct or not. It will not be out of place to point out that India is now a member of the Washington Accord which stipulates a minimum standard of its post graduate and PhDs. India's GDP per capita of PG is only US $ 1450 compared to a GDP of $33,400 in Japan. The number of PhDs per thousand are 7, 4 and 0.35 in Japan, USA and India respectively.

The Prime Minister terms the Indian talents going abroad is not '*brain drain but brain gain'*. However, the question remains who gains. May be the country gains monetarily from the remittances as sent by the skilled and semi-skilled workers mostly in the Middle East countries. But the most talented lot of Indians who migrate to developed countries like USA, Europe, Canada, Australia, etc. are being utilized by them to innovate, discover and develop their own institutions.

While India imports equipment and products developed by Indian origin scientists and engineers abroad, those countries are importing the best brains from India free of cost. China has understood this game very well. Most of their reputed scientists and technologists are encouraged/ inspired to return to their homeland after successful completion of studies and training abroad. Most of the Chinese institutions, are headed by eminent persons who have been educated and trained abroad; they have made phenomenal progress over the years. Talented Indians who migrate abroad continue to stay and settle there partly because of high pay and perks but mostly due to a congenial atmosphere for research & development and also due to the recognition of the work done by them.

It seems IITs are built to supply the requisite manpower for further development of the advanced countries in the world. Most of the IITans prefer joining PG/ PhD. program abroad thereby enriching foreign institutions. Unless this trend can be stemmed, India will continue to remain dependent on foreign knowhow and import foreign products/ technology at exorbitant costs. The current status of research in engineering and technology in a vast country like India can be gauged from the fact that the annual turnout of PhDs in engineering and Technology had decreased from 506 in 1979 to 374

in1996 (AICTE-1999). Although the current annual intake of PhD has now increased to 1500, the actual number who successfully complete it is much less. Approximately 400 research scholars complete their PhDs. in engineering and technology annually mainly due to lack of qualified and capable faculty. Going by the 1:2:4 ratio of cadres of professors, associate professors and assistant professors, the shortage of PhDs. in India in teaching institutions alone is estimated as 60,000 (Rama Rao,2013). Research and postgraduate education in engineering and technology is confined to only a few institutions like IITs. Despite attractive scholarships, nearly 60% of the over 19,000 sanctioned postgraduate seats (in 191 institutions) remained vacant while less than 7,000 completed the PG courses annually. Very few of IIT/ NIT students join PG courses in India; the majority of the PG students come from private/ state run colleges for getting an IIT /NIT stamp. The quality of the PG education has been discussed by the author in an earlier paper (Mazumder,2008). The low turnout and the poor quality of postgraduates who constitute the supply source of teaching and consultancy profession, is of major concern vis-à-vis the country's technical education system.

Need For Collaboration Between Educational & Research Institutions and Consultancy Organisations For Improving Quality

Research and development must have strong linkages with industry for meeting the country's socio-economic goals. Since university professors and the research scholars working under the them comprise an enormous pool of expertise and resources, appropriate collaboration must be built up between the educational and research institutions and the consultancy organisations for improving quality. The University curricula also must be upgraded to cover the emerging areas in science and technology (Madramootoo,2000). Inter-Institute collaboration between academic institutions and industries is vitally needed for improving the standard of both the educational and research institutions imparting knowledge and the practicing institutions making use of the knowledge, (Chakraborty, 1999). That can be achieved through several ways e.g. exchange of faculties, supporting research funding, carrying out research and consultancies jointly, exchange of knowledge, information and experience, participation in workshops and conferences; offering short term refresher type courses jointly with faculty drawn from both academic institution and industries, organizing training/ orientation program, taking active role in strengthening professional societies; reading journals and contributing papers in the technical journals; writing text books/ handbooks jointly; participating in the preparation of codes, manuals, guidelines, etc.

Engineers in a consultancy organization or in the field cannot keep themselves abreast with the latest research and developments except those few with an academic bent of mind. Similarly, an academic person has very little opportunity to gather practical experience, although he/ she may be equipped with the latest mathematical tools and computational techniques. Collaboration between field organizations and educational institutions will help in pooling the resources together for the most economic, efficient and time bound solution of the problems being faced in different aspects of planning, design, execution, operation and maintenance of projects. (Mazumder, Jan., 2017a). Such collaboration eventually helps in development of innovative methods and inventions, new technology, new software helping further growth of profession for the national development. All the collaborating institutions get enriched and attain a new height to face any challenge posed by the government and the society.

Considering the challenging problems being faced by India, it is of utmost importance to promote R&D in the technical & research institutions and consultancy organisations and the industries for leveraging innovations and inventions - a key to socio-economic development in a sustainable and environmentally friendly manner. Inter-institute collaboration will improve the quality of the scientists, engineers and technicians who have to be equipped with wide technical knowledge based systems integrated with work experience, creative skill and dexterity in tune with the changing socio-economic and technological scenario in the fast changing world with global competition.

Post graduate students can carry out the jobs related to the sponsored research and industrial consultancy works - a part or all of which may be included in their dissertations - both at the Master's and the Ph.D. levels. It is principally due to the contributions made by the young and energetic scholars that the department progresses and the laboratories develop. It also helps in creating quality manpower essentially required for teaching, research and consultancy jobs.

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