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Present & future trends & challenges in Chemical Engineering Education in India

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ABSTRACT

Education empowers people to develop personally and become politically active. This paper reveals recent trends impacted by shifts in academic research and industrial needs. Major paradigms have emerged in unit operations and engineering science. In recent times, Bioengineering and nanotechnology will play a major role in current emerging paradigms of process, energy and biomolecular engineering. This paper shows education in chemical engineering and its visions and mission including the essence of curriculum reform and personnel development to meet today and future challenges of Indian chemical engineers. The paper attempts to replicate the impact of professional chemical engineers to the nation's development and improvement in the welfare of the society through producing skilled engineers and conducting applied research. Emphasis should be provided to promoting innovation in curriculum to promote creation of new products, process, and encouraging entrepreneurs.

Keywords: Education, Bioengineering, Bio-molecular engineering, Chemical engineering, Curriculum.

I. INTRODUCTION

Despite its numerous accomplishments, many challenges and opportunities face the engineering profession. The development of chemical engineering requires that these challenges are properly addressed and opportunities be fully assessed and exploited beneficially where possible, and that future trends be tracked and speculated upon in a reasoned manner. Challenges, opportunities and trends in engineering education can be general or specific to individual engineering programs or faculties, this article concentrates on general factors. The objective of this article is to contribute to the development of chemical engineering education by suggesting possible future trends, and fostering continued discussion of and appropriate action on the challenges and opportunities facing engineering education. If challenges are to be properly addressed, opportunities optimally exploited, and future trends clearly estimated, topics needs to be debated fruitfully. Of great influence seems to be the actual situation in the job market for engineers (chemical engineers inclusive), which includes early retirements, and cautious recruiting practices by the employers. Today India is one of the largest producers of engineers after China and US. [20]

Later, chemical engineering departments were set up in few other tertiary institutions. Numerous universities are available in India of which considerable percent of them offer chemical engineering. Today, Institute of

National Importance like IITs, NITS, Elite status granted State and Private Universities provide undergraduate and post-graduate courses in india. Enormous growth in chemical engineering education was seen in the year when approval was given to private owned institutes for exploring the courses in chemical engineering and technology.Some graphs & data representing student enrollment, no. of colleges, students placements etc are shown below.

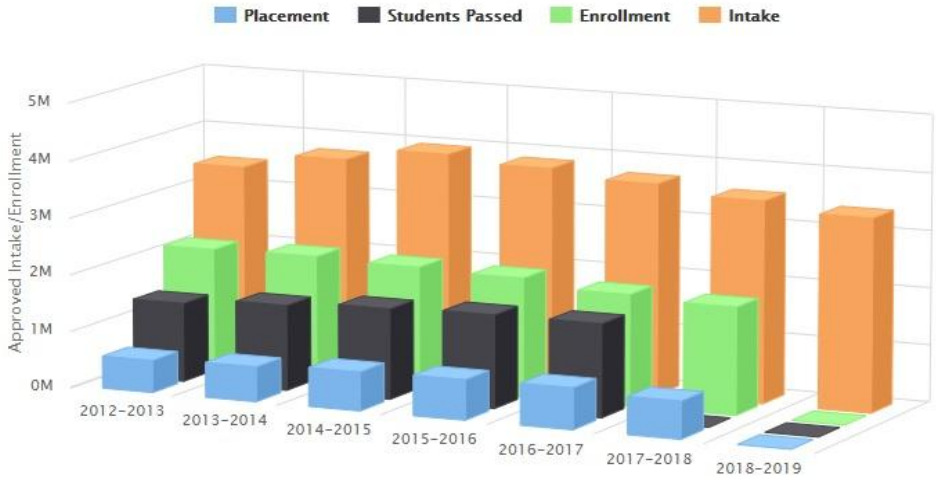

Table no.1 Graphs of approved intakes, enrollments during recent years. (Source-AICTE)

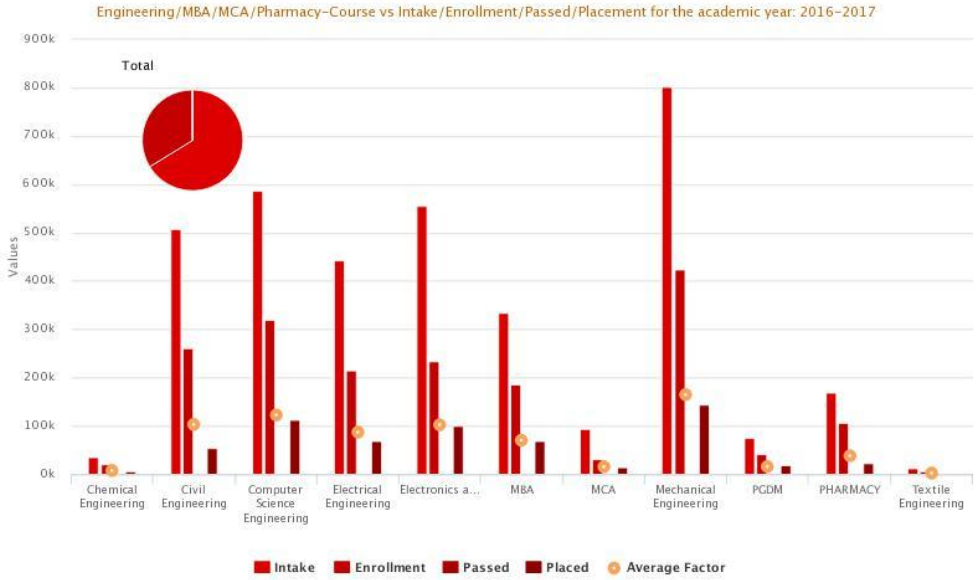

Table no.2 Data showing students placements, enrolled during 2016-17.(Source-AICTE)

Total Institutions 379	New Institutions 4	Closed Institutions 3
Total Intake 169633	Girl's Enrolment 29707	Boy's Enrolment 70384
Faculties 43194	Students Passed 0	Placement 37966

Table no.3 Data showing institute intakes, faculties, enrollements during 2017-18.(Source-AICTE)

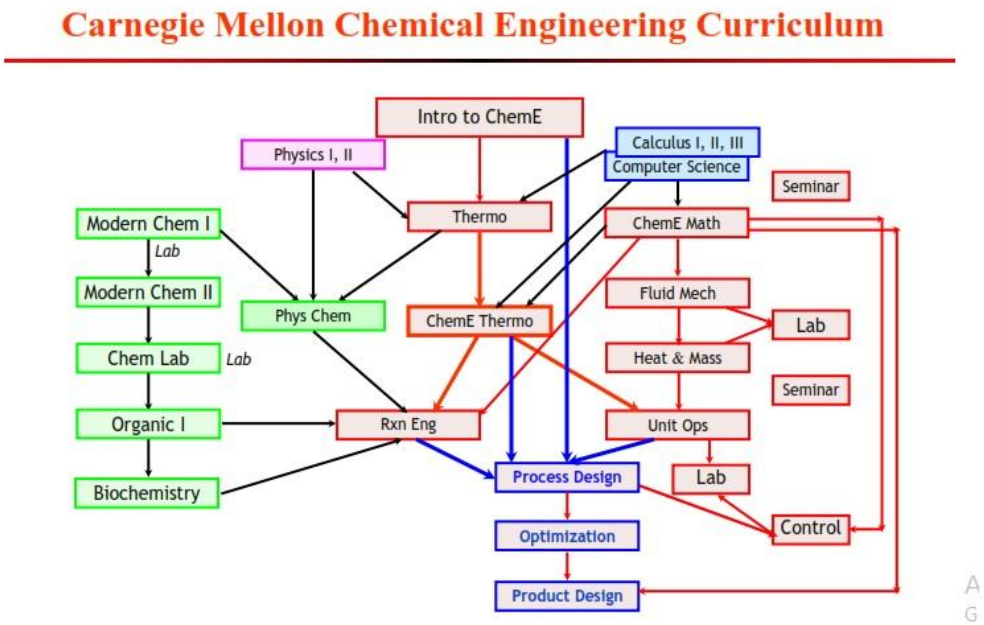

Table no.4 Carnegie Mellon Chemical engineering Curriculum

I. Admissibility criteria for UG/PG Program

The criteria's needs to be fulfilled who wish to enroll to UG degree program in any discipline of engineering,

Chemical engineering inclusive. Criteria are,

1. Candidate should be an Indian National and should have passed the HSC examination of Maharashtra State Board of Secondary and Higher Secondary Education or its equivalent examination
2. Secured minimum 50 % marks in the subjects Physics, Mathematics and Chemistry/Biotechnology/Biology.

3. Obtained a positive Composite score and All India Rank in JEE (Main) given by CBSE. Criteria for students who wish to enroll for PG program are:

The candidates should fulfill the following eligibility criteria:

1. Candidate should be an Indian National.
2. Candidate should have passed Bachelor degree or equivalent in the relevant field of Engineering/Technology from

State Governments/MHRD approved institutions.

3. The candidate should possess Bachelor degree in the relevant course of Engineering/Technology as specified in the eligibility criteria of the concerned University for which admission is being sought to a particular Post graduate

degree course/specialization.

III. CHEMICAL ENGINEERING SYLLABUS IN INDIAN UNIVERSITIES

The University Grants Commission (UGC) sanctions program of Indian universities in collaboration with All India Council for Technical Education (AICTE) with respect to engineering disciplines. The Chemical Engineering institutes in India operate on the syllabus guidelines laid down by AICTE. The old-fashioned curriculum was successful for many years and was oriented towards a world of different conditions: mass, stable and well-paid employment; protected and buoyant economy. There is a need for curriculum reform to prepare a Chemical Engineer of all times. [**10**]. The curriculum provides a background in basic sciences including Mathematics and Physics. This background is essential for a rigorous study of topics central to chemical engineering like Multicomponent thermodynamics and kinetics, Transport phenomenon Separation processes, Process design and control, Plant design and systems engineering for process safety, Environmental protection and economic operation.

The significance of traditional Chemical Engineering has to be preserved as the basis for new developments as well as for traditional engineering; however it has to be expanded to new subjects, at least new in our environment, as are bio, nano, medical and computational engineering. Many allied branches have evolved nowadays such as Petrochemical, Polymer, Paints, Oleo chemicals and surfactants, Food engineering, Paper and pulp, Biochemical engineering. Moreover, the formation for enterprise and for research and development based on new knowledge should be stressed. Innovative principals of Chemical Engineering have to be sustained on strong and modern development in mathematics, chemistry, physics and biology. The new directions of the curriculum should embrace new scope: from nano to macro scale; steady and unsteady states; traditional and new frontiers of Chemical Engineering science and technology, business vision and a universal perspective.

IV. CHALLENGES OF CHEMICAL ENGINEERING EDUCATION IN INDIA

India is a large country with adequate manpower and resources. Nature has been very kind to us in that abundant resources like coal and minerals. However, we have now come to the realities with our

potentials to some extent. India is rich in natural resources and being recognized as one of the fastest growing economies in the world. Years by, America used to be called new world, on the same planet with India. The country has observed many developmental ideas but lack of understanding, patriotism, and dedication seem to have put these plans in fragments. Today India has to work much faster and constructively in the areas of Critical Infrastructure, Unemployment, Human Capital Development, National Security, Intelligence and Wealth Creation, Energy alternatives & its generation, Environmental friendly processes and Prevention of Terrorism.

Till date, India is a developing nation. There is a basic requirement to produce better engineers with excellent potentials and skills to cater the needs of the industry. Energy, Oil, Food, all non-oil and manufacturing subsector can be the main basis for achieving development in India. Once the manufacturing sub sector is not functioning, the multiplier effect it has on other sectors of the economy that can help awaken and generate all round development will be lacking. Today there is a need to emphasize on alternative fuels, renewable energy, green technology, environmental engineering etc. Hence encouraging research and development in this stream will play a vital role in strengthening our education. More emphasis should be provided to Bioengineering and Nanotechnology.

V. FUTURE TRENDS IN CHEMICAL ENGINEERING EDUCATION

Engineering education has evolved since its origins. One of the strongest features of engineering education, in fact, has been its resilience and flexibility, and its ability to adapt and evolve as new challenges, opportunities and new realities become apparent. Some have attempted to provide pathways to the future of engineering. Despite the appearance of confusion that sometimes seems to be associated with engineering education, there are discernable trends. Many of these trends are discussed here, where they are grouped into several categories: advancing fields, refocusing priorities, enhancing professionalism, advancing teaching and learning methods and increasing diversity.

Bio-engineering has been added a new frontiers in the field of chemical engineering. Many Bio-medical engineering departments have been setup to cater this new field. Different universities have now changed names of chemical engg depts. to Chemical & bio-engineering and bio-molecular engineering, Chemical and biological engineering. (Eg. Cornell, U. Penn., Illinois, Georgia Tech & Colorado, Northwestern, Notre Dame, Wisconsin). Indian universities have started more specialized courses in allied branches of chemical engineering such as polymers, paints, oleo-chemicals & surfactants, food, petroleum, pharmaceuticals, perfumery, cosmetics etc. Nanotechnology has been an emerging area in chemical engineering research and applications. It is blended with different allied interdisciplinary branches of chemical and all other forms of engineering to provide a better technological development and application in day to day life. Faculties in Indian colleges are publishing papers in chemical engineering instead which should be promoted to file more patents in terms of applications to contribute more to mankind.

Traditionally, Chemical engineers have catered to interdisciplinary branches of engineering and technology. Today there is an increased emphasis on science rather than engineering. Many professors in

Indian engineering colleges are not chemical engineers which have increased multidisciplinary approach. Process engineering and design are extensively are outsourced to retired industry professionals. Numerous chemical and allied industries require researchers and employees possessing critical scientific and engineering skills. Vital industries in US are now chasing biotechnology with shear knowledge of chemical engineering.

VI. FUNDING AND FACILITIES.

India is the largest democracy in the world, functioning on the principle of federal system. Universities are owned by the Central, State governments and Private individuals. Government has set up Institutes of National Importance such as Indian institute of Technology (IITs), National Institute of Technology (NITs). The state governments have also set up University departments and Institutes having Elite status and potential of excellence. University Grants Commission (UGC) is a statutory body of government of India provides funding for various research projects in IIT, NITs, State, Central and deemed universities. Council of Scientific and Industrial Research (CSIR) is also government organisation with different laboratories and institutes throughout the country provides funding to boost research in scientific field. The public universities rely principally on the governments for funding while the private universities obtain their incomes from the fees they charge the students.

Today, The IITs and NITs have well equipped laboratories, furnished classrooms, good qualified and experienced staff and spacious campus. On the same grounds, some private institutes and state universities have developed. In the present circumstances, there are many reputed institutes for higher education with all the facilities for promoting teaching, learning and research. Still some of the Institutes need to be developed on same grounds for providing an impetus to the research and teaching. It will lead to production of sufficient and prepared science graduates necessary for driving the technological and socioeconomic development.The numbers of engineering institutes have increased with respect to their intake capacities and indirectly the aspirants.

Some institutes do not possess permanent staff, classrooms and laboratory equipments. The inadequacy in teaching, laboratory and workshop facilities has contributed to the diminution of the quality of the chemical engineering graduates in India. The implication of the scenario is that only a small proportion of the students benefit from the current pedagogical system. The high price of computer and teaching aids possession is a major constraint to procurement of the items. **[13]**

The National Assessment and Accreditation Council (NAAC) is an autonomous body established by the University Grants Commission (UGC) of India to assess and accredit institutions of higher education in the country. Guided by its vision and striving to achieve its mission, the NAAC primarily assesses the quality of institutions of higher education that volunteer for the process, through an internationally accepted methodology.**[18]**

The National Board of Accreditation (NBA), India was established by AICTE (All India Council of Technical Education) as an autonomous body for periodic evaluations of technical institutions & programmes basis according to specified norms and standards as recommended by AICTE council. It has the full authority

to recognise or derecognise institutions and programmes under them. It is the only authorized body in India entrusted with the task of undertaking accreditation of technical education programmes.[**17]**

Indian Institute of Chemical Engineers(IIChE) was established just before the Indian Independence to cater the need for such a forum within the country to rear the nascent initiatives for spread of chemical engineering education and foster the interest of the profession.The Institute has emerged as the apex professional body of chemical engineering professionals in India and has developed a distinct profile of its own which is everchanging. Even as the IIChE is always moulding itself and playing a proactive role to keep up with the dynamic needs of the society and the economy. The activities of the Institute includes organizing meetings, conferences and seminars; arranging workshops, refresher courses and counseling sessions; promoting research; guiding chemical engineering students in career planning; and initiating any other activities which are of social, technical and professional relevance to their members. They serve as open fora for their members who regularly gather for informal get-togethers and exchange of notes. The Regional Centres also confer awards, prizes and scholarships.

VII.STAFF TRAINING AND RETENTION

The training of academic staff is ordinarily a continuous exercise to ensure consistent improvement in the quality of their outputs. The technical exercise is in two-fold: training to acquire least requirement (PhD) to teach and continued professional training. Typically, native training within a country is inexpensive than overseas training but more active because of inadequate facilities, literature and disruptions arising from the need to meet the necessary demands. However, over time it has always been difficult to get the trainees back to their respective countries after the completion of their study. When related to economy, one US dollar was equivalent to approx. 65 Indian rupees or more. Hence, this exchange provides good attraction to move out. **[1]**

Salary is one of the issues; self-fulfillment in terms of output via research efforts is also part of the driving force. The salary and service benefits paid to engineering teachers in India is insufficient, they migrate to other countries especially the United States of America, or local industry for better pay. AICTE has now given the guidelines of grade pay in the engineering institutes in different class of professor, reader, asst. professor and Lecturer. Academics from within migrate to foreign countries because of high wages that they pay to the academics and relatively better equipped laboratories. The picture has changed today. Many universities have now developed well equipped laboratories and college campus. Private, state and central universities have now started a high pay scale according to AICTE norms to the faculty members to inhibit the migration. Government has taken initiatives to invite foreign industries to setup their plants in India which could help in reduction of drain**. [15]**

Conclusion:

- The discipline of chemical engineering is undergoing a major transformation which continues to withstand the tests of time. Negligence may pose potential threat to the industrialization and indirectly

economics of any country. It is obvious that there his lack of professional commitment among members of the engineering profession.

- Skills developed as result of a solid foundation in the fundamental sciences - chemistry, physics, mathematics and now increasingly, biology - along with a quantitative engineering science approach, have permitted chemical engineers to move rapidly into many emerging technologies. Their impact in the newer areas will be enhanced by continuing the core curriculum, and augmenting it by expanded examples of applications, incorporating biology in all core courses, and including orientation towards both product and process design. By offering imaginative courses using new teaching methods and tools, and by providing intellectual challenges, we need to attract the best and the brightest to chemical engineering, and educate them to become leaders in industry, academia and society.
- The potential for a new Golden Age of Chemical Engineering then rests on transformative trends that favour leadership and contributions from chemical engineering and a broad vision of the profession. Through this principle, we can attain our ultimate professional goals to create value and to advance the quality of life.

- There is need closer interaction with industry; Need to keep core Chemical Engineering Knowledge and emphasize fundamentals: basis life-long learning; Need to modernize curriculum and add flexibility, better introduction at molecular level, Increase relevance to energy (alternative/renewable) and sustainability issues, Exposure of students to new chemical process technology, Introduce product design as complement of chemical industrial process design, Underline process operations, enterprise planning, More impetus to link with other industrial sectors (pharma, electronics)
- Changing scenarios in the world have led to increase the emphasis on bio and environmental engineering.
- Promotion of procedure to recruit best young talents to join chemical engineering.

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