Engineering Education Framework in Leading Countries

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ABSTRACT

The engineering education system is designed differently in different countries. The purpose of the current work has been developing the framework for describing different models used for engineering education in different universities/colleges of different countries in world. The framework presented in the paper is the result of research project focused on understanding and identifying the ways in which universities/ colleges implement engineering and engineering design in their institutes. The discussion of different models included has been determined on the basis of an extensive review and study of the available resources in the fields of engineering and engineering education.

Keywords : Engineering Education, Universities, Colleges.

INTRODUCTION

The world is full of engineering. Engineers are the ones who create something new. Engineers have prompt role in all aspects of human life. They provide various solutions to the problems that put an impact on all. It's worth putting time an effort to be an engineer. It's the time when qualified engineers are in great need like always. Fast advancements in technology and limited natural resources have certainly increased the demand of new engineers greater than ever before. Hence, the engineering institutions are in immense pressure to build up job readiness of these people as better skilled workers are required as per market demand.

Engineers must have a knowledge of nature that goes beyond mere theory—knowledge that is traditionally gained in educational laboratories (Lyle D. Feisel, Albert J. Rosa (2005). Many studies have been conducted in many countries to determine the technical and personal abilities required of engineers by today's industries (Lang, J.D., Cruise, S., McVey, F.D. & McMasters, J. (1999), Industry expectations of new engineers: A survey to assist curriculum designers. Journal of Engineering Education, 88, 1, 43-51)

Learning styles of the most of the engineering students and teaching styles of most of the engineering professors are incompatible in several dimensions. (Richard M. Felder, Linda K. Silverman, 1988). Recently the engineering education is undergoing transformation in terms of the teaching and learning in engineering universities or colleges. These themes and future direction have impacted the engineering education globally. There exist many colleges/universities in the world that are changing the method of providing engineering education.

ENGINEERING EDUCATION AT GERMANY

“Everybody knows what the label 'Made in Germany' Means”

Germany is the most renowned country in the world for engineering education. Germany has grown as a result of enormous researches and developments in the field of engineering educational programmes. Prospective candidate of engineering degree prefer to first checkout the various opportunities and options available and approachable in Germany.

German's Vocational system has been around for decades and is deeply embedded in society. Youngster who are not qualified for but interested in going to university can join a programme in which they work part of the week for a firm that pays them and teaches them relevant skills. The rest of the time spent in school. Roughly two out of three young Germans go through this system.

It is a very practical approach where young people are

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partly hired, partly subsidized in this dual education system. Students receive some money but not too much and their education is covered by the company that hires them. For example students trained in Siemen's Training centre, about 90% stays with the company and they are loyal and proud to be at the company. It is good investment for both the young people and the companies involved. Others after Apprenticeships, the trainees often have jobs to walk into variety of sectors from primary to tertiary.

Chambers of Commerce and Industry bodies of Germany are involved to ensure that the work and the teaching are matched. Youth unemployment in Germany is under 8%, compared with 56% in Spain and 38% in Italy (http://www.bbc.com/news/business-24131534)

The highlighted points of engineering education at Germany are:

Apprenticeships - As the practical knowledge along with theoretical is very important but not many engineering education structure of many countries provide such trainings. These trainees also earn while they are learning the popular German engineering. Trainees also come from Spain, Lithuania, Britain for Germanys famous 'earn as you learn' model. The British business group, the CBI cited Germany as one of the leaders in vocational education. (www.bbc.com)

Scholarship Opportunities – Germany offers scholarship opportunities to international students be it universities, research organizations, government organizations, corporate (www.mastersportal.eu)

Innovation – Innovation is the essence of Germany. It not only frames new industries, but also imparts the existing industries with new ideas and technologies.

Live Research Projects - The Fraunhofer Institutes which is supported by government move their ideas into the marketplace in novel ways (www.hbr.org). Fraunhofers model is a great government-industry association (www.asme.org). Technical University of Munich also collaborated with Siemens', General Electric, BMW to offer students live research projects (www.mastersportal.eu).

USA ENGINEERING EDUCATION

American BS engineering degrees are technically very rigorous in terms of higher level math and science skills and advanced engineering techniques in line with an American Associate of Science degree (AS). MEng degree takes five years to complete, contain rigor essentially. (https://peer.asee.org/comparison-of-engineering-education)

Students admit at the age of 17 and all students in the US will take the same courses for the first two years of university, and then specialize for the remaining two years. This allows the student to decide on a field of study roughly at the age of 20, and at the same time allows the student to look at a whole range of fields that may interest them. The first two years (particularly for engineering) prepare the students in a way such that whatever field they decide to specialize in, they can without additional prerequisites becoming a professional engineer in the US varies from state to state. However, the general process requires a degree from an accredited 4-year university, passing an engineering test after graduating, and then working in industry for 3-4 years, where another test is then assessed ("Model Law"). http://ncees.org/wp-content/uploads/2012/11/Model-Law-2015.pdf)

Accreditation Assessment- In the USA, the normal routine for engineering accreditation assessment is a once-every-six years visit by ABET. While this visit is rather intensive, it occurs so infrequently that some faculty members are prone to not thinking about it for long periods of time.

Course, exam and assessment: USA system gives 15-20% weightage for humanities, social science, or communication courses. A USA engineering degree typically has on the order of 50-60% of the plan of study dedicated to engineering courses and around 25-30% of the plan of study dedicated to math and science fundamentals. This indicates a different focus which is worthy of note. The USA courses often balance lecture, lab, recitation, and class related projects all in once course. The quantity of assessment items (assignments, projects and exams) is much higher in the typical USA engineering program. About 40% would fail in virtually any USA classroom. (https://peer.asee.org/comparison-of-engineering-education)

Why people choose USA over other Engineering Education?

Youngsters also choose other country as an option for engineering education and that is USA. Strong reasons exist for pulling candidates to USA for engineering. Almost 1,00,000 international students enroll themselves in UG or PG studies in USA every year (www.

mastersportal .eu). Most prominent reasons being:

1. Salaries and Salary growth rate of engineers from USA are generally high
2. Demand for engineers in USA is constantly growing
3. Opportunities to work in top international industries
4. Broad range of subjects
5. Big number of expert faculties available for specialization subjects
6. Easy access to venture capital, a more open –minded approach
7. Have all resources, and facilities for research

In Massachusetts Institute of Technology students are motivated for uniting MITs engineering expertise with public service. (www.usnews.com)

South Korea: A Study place for few International Engineering Students

South Korea is a combination of old traditions and modern culture. It sets itself unique and different from the other countries in this regard. South Korea especially Seoul, is also undergoing revival process where it created a niche and came out as an option for students to think about. It is offering some extremely good research opportunities and challenging courses known as best in Asia. (www.studyinternational.com)

South Korea far outpace the US in the percentage of young adults with college degrees i.e. 63% versus 41 % and K-12 students outperform US students in international assessments. Korea has transformed it from poor country with illiterate farmers into a high tech powerhouse and start with compulsory elementary education and a standardized curriculum for all the children of the country from rural to urban. More than 80% high school graduate go to higher education, one of the highest in the world. (http://hechingerreport.org)

The education is closely regulates by the government and quota in different programmes are set as per economy needs. South Korean Government has also created a flagship university - Kaist (Korea Advanced Institute of Science & Technology). The best students in the country were recruited with free tuition and an exemption from mandatory military service. (http://hechingerreport.org)

1. It's a high quality and globally respected education place with outstanding educational rankings. (Seoul National University) (www.usnews.com). Academic environment is highly competitive. (www.internationalstudentinsurance.com)
2. According to Forbes magazine, It is considered one of the best in the world for information and technology. (www.forbes.com)
3. It has gained position in terms of Innovation too. (www.bloomberg.com)
4. It focuses on research and developments too. (www.studyinternational.com)
5. Its affordable as fees is quite low and offers scholarships too (www.studyinternational.com).

JAPANESE ENGINEERING EDUCATION

Engineering Education in Japan is a product of an entire educational, cultural and professional environment and it has more homogeneous student than other countries. Engineering Education in Japan is characterized by six interesting themes: hardworking and preparation, team works and fraternity, high discipline and mentorship in universities and companies, research based education, high social position of professors/instructors, and, close relationship between universities and industry (Ahmadi S, Bevrani H, Jannaty H, 2012).

1. **Hardworking and preparation -** They are well prepared with a fairly uniform level of knowledge (at least in mathematics and physics).
2. **Team works and fraternity -** The students enter the university together as a new group at the beginning of the school year. Within each engineering discipline they attend the same set of courses together, and go ahead with their group. The time of being together will increased, as the student join a specific laboratory (Kenkyushitsu) from the fourth year of bachelor study. (J. R. McGuire, 1996).
3. High discipline and mentorship in universities and companies - Each professor should have his/her own lab for twenty students. These labs have mixture of fourth year bachelor students, master and Ph.D. students. Name of each lab is usually taken from the name of owner professor. A lab is considered as a family in the university, and the professor is responsible to define research projects, organize the lab budget, making contract with companies, and all

other issues. Within a lab, there is a strong sense of camaraderie, the upperclassmen and professors are given the responsibility not only for mentoring the younger students but to young faculty members also. This mentoring is perhaps one of the great reasons of Japans engineering education success.

4. Research Based Education - The importance of high-tech world class research is strongly emphasized by the government as well as Japanese high-tech companies. They include the competitive research funds such as grants-in-aid for academic research, the "21st Century Center of Excellence Program" (COE), and its successor, the "Global COE Program", in which the government concentrates its financial support on a specific number of universities for building up world class centers of learning. (National Institute for Educational Policy Research (NIER), 2011)
5. Close Relationship between Universities and Industry - In Japan on-the-job training is an essential part of an engineer's career, which leads to an understanding of design and manufacturing processes which not achievable in the university (J. Frey, 1993). Some companies educate the graduates to get sufficient number of engineers to fit the newly growing fields. Many Japanese high-tech companies have degrees in engineering. Once graduates from Japanese universities joined a high-tech company they would then embark on an intensive company run education program designed to make them ready for work.
6. High Social Position of Professors/Instructors – in Japan academics are still considered as noble profession and have a high honour in society.

UK ENGINEERING EDUCATION

There is no consistency across the UK, as again the separation of governance in England and Scotland has led to different systems. The four-year curriculum which led to the awarding of degrees of Bachelors in Engineering (BEng) and Masters in Engineering (MEng) at an English university.

At a Scottish university, the program lasts four years, like the English program, it awards a highest degree of Bachelors in Engineering with Honors (BEngH). Moreover, this program was found to be much less technically rigorous than the English MEng in terms of higher level math and science skills and advanced engineering techniques results in a student graduating with a skill set. However, a second type of engineering degree program exists at some Scottish, which takes five years to complete, it will result in an MEng degree and will contain rigor

Course, exam and assessment - A typical UK course would have one coursework assignment and one exam and the entire grade for the course was based on those two items. In some project courses, the entire grade was based upon a single assessment of one project.

Accreditation Assessment- In the UK, external reviewers participate in tier one and tier two exam boards. They also present a report, comparing their view of the school's performance, based on what they saw during the Exam Boards, to other universities and to recommended corrective actions from reports produced after previous exam board meetings.

Educational Environment - At the university level, dress is formal and there is little focus on university sports, with numbers of spectators attending very limited. (https://peer.asee.org/comparison-of-engineering-education)

The Future Prospects - The NMITE - New Model in Technology & Engineering, is Britain's first 'greenfield' in 40 yrs. It has unveiled few highlighting points in their curriculum to be implemented. It shall focuses on Liberal Engineering with 3 years (46 weeks), courses will be delivered using Block Learning System i.e., each block will have one or two key concepts incorporate project or problem with defined outcome, project and team based learning with projects and problems sourced from industry for real world experience and at least one major project /internship sponsored by industry. (http://nmite.org.uk/curriculum/)

INDIAN ENGINEERING EDUCATION

India is one of the largest producers of engineers in the world. In India, there are several technical universities and colleges that are providing engineering courses. The engineers in India have established their reputation for engineering and design skills.

The main governing body in India at the tertiary level is All India Council of Technical Education and University

Grants Commission. It enforces standards, gives advice to government, and also supports coordination between the centre and the state. Few renowned institutions of India are Indian Institutes of Technology (IITs), National Institute of Technology (NITs), Indian Institutes of Information Technology (IIITs). Universities in India are controlled by Ministry of Human Resource Development.

Enrollments - As per the HRD ministry, India has 6,214 engineering and technology institutions which enroll 2.9 million students. Near about 1.5 million engineers are released into the job market every year. (http://indiatoday.intoday.in). IITs enroll almost 8000 students annually (https://en.wikipedia.org).

Course, Exam and Assessment – The engineering courses are at diploma, undergraduate postgraduate and doctoral levels. Diploma is a 3 year course after 10th. Undergraduate (B.Tech) is 10+2 with PCM. It is semester wise 4 year full time degree programme with internal and external assessment. PG is an M.E (Master of Engineering) or M.Tech (Master of Technology) degree which is 2 year course after B.Tech. Ph.D is 3 years duration research course with masters degree in respective discipline. (https://www. sarvgyan.com/ courses/engineering-courses)

Accreditation Assessment – The accreditation in India is done by National Board of Accreditation (NBA) initially established by AICTE (All India Council of Technical Education) in 1994. It is for periodic evaluation of technical institutions and programmes according to specified norms and standards as recommended by AICTE council with the objective of Assurance of Quality and Relevance of Education. For the process of accreditation all the prospective technical institutions register themselves with the board through online for Tier I and other programmes where they move further step by step. (http://www.nbaind.org/views/Home.aspx)

Few Prospects – Researchers of India have emphasized on universally preferred Science, Technology, Enginering and Math (STEM), statistics and data analysis skills, are of todays requirement and prority (Mohanty A, Dash D, 2016)

CONCLUSION

Over the last few years many steps have been taken to develop and promote teaching excellence within the global universities/institutes. The curriculums have improvised and faced a revival process for student learning which have been implemented across the world universities. These globally renowned models need to be thoroughly studied and researched and a new innovative model needs to be developed and implemented for the engineering education in India for it to be placed at a better position from the current deterioring scenario.

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